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QUALITY ASSURANCE PROJECT PLAN FOR THE JEFFERSON COUNTY DEPARTMENT OF HEALTH'S (JCDH) AMBIENT AIR QUALITY MONITORING PROGRAM

2/1/2007

Prepared for:

The Air and Radiation Protection Division

Submitted by:
Randy Dillard, Air Monitoring Supervisor

JEFFERSON COUNTY DEPARTMENT OF HEALTH
1400 SIXTH AVENUE, SOUTH P.O.BOX 2648 BIRMINGHAM, ALABAMA 35202 205/930-1550 FAX 939-3019

Environmental Health Services
Wayne Studyvin, PE, MSCE, Director
Frank Phillips, PE, Assistant Director

February 1, 2007

Merilyn Maycock
U.S.E.P.A.
980 College Station Road
Athens, Georgia 30605

Dear Ms. Maycock:

Enclosed is a copy of the Quality Assurance Project Plan for Jefferson County Department of Health's Ambient Air Quality Monitoring Program.

Please contact Randy Dillard of our staff at 205-930-1281 if you have any questions or concerns in this matter.

Sincerely,

Wayne Studyvin, Director
Environmental Health Services

WS/crd

Enclosure

1. QUALITY ASSURANCE PROJECT PLAN IDENTIFICATION AND APPROVAL

Title: *Quality Assurance Project Plan for the Jefferson County Department of Health's (JCDH) Ambient Air Quality Monitoring Program*

The attached *Quality Assurance Project Plan for the Jefferson County Department of Health's (JCDH) Ambient Air Quality Monitoring Program* is hereby recommended for approval and commits JCDH to follow the elements described within.

Jefferson County Department of Health

1) Signature:_____ Date 2/1/2007
Wayne Studyvin, Director
Environmental Health

2) Signature:_____ Date 2/1/2007
David Wootton,
Principal Air Pollution Control
Engineer, Air and Radiation
Protection Division

3) Signature:_____ for Date 2/1/2007
Joe Wilson,
Environmental Health Program
Manager/ Quality Assurance
Manager, Air and Radiation
Protection Division

4) Signature:_____ Date xx/xx/2007
EPA Region 4 Quality
Assurance Officer

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David Wootton, Principal Air Pollution Control Engineer (PAPCE), Air and Radiation Protection Division (ARPD)		
Joe Wilson, Environmental Health Program Manager/ Quality Assurance Manager (EHPM/QAM), Air and Radiation Protection Division (ARPD)		
Randy Dillard, Air Monitoring Supervisor (AMM), Air and Radiation Protection Division (ARPD)		
Jeremy Hardin, Environmental Health Program Supervisor/ Quality Assurance Coordinator (EHPS/QAC), Air and Radiation Protection Division (ARPD)		
Merilyn Maycock, U.S. EPA, 980 College Station Road, Athens, Georgia 30605		

4. PROJECT/TASK ORGANIZATION

JCDH's Air and Radiation Protection Division (ARPD) is organized into three main sections: Engineering, Enforcement, and Air Monitoring. The Principal Air Pollution Control Engineer (PAPCE) of ARPD has the overall responsibility for managing these divisions according to stated policy. The PAPCE delegates the responsibility and authority to develop, organize, and maintain quality programs to the Environmental Health Program Manager/ Quality Assurance Manager (EHPM/QAM). The PAPCE also delegates the responsibility and authority to implement quality programs and procedures to the managers of each section, in accordance with the Quality Management Plan. The direct responsibility for assuring data quality rests with these managers and the line supervisors under them.

The organizational structure of for the implementation of the monitoring program is shown in Figure 4-1. The following information lists the specific responsibilities of each significant position within ARPD.

4.1. Air and Radiation Protection Division

The Air and Radiation Protection Division maintains the modeling and emissions inventory and is responsible for all aspects (quality assurance, data collection, and data processing) of JCDH's Ambient Air Quality Monitoring Program.

Environmental Health Program Manager/ Quality Assurance Manager (EHPM/QAM). The EHPM/QAM of ARPD has direct access to the PAPCE on all matters relating to ARPD's operation. The EHPM/QAM's duties include, but are not limited to the following:

- maintaining oversight of QA activities
- reviewing budgets, contracts, grants and proposals

Air Monitoring Manager (AMM). The AMM reports to the PAPCE of the ARPD. The AMM's duties include the following:

- maintaining oversight of the QA activities
- maintaining overall responsibility for the monitoring network design and review
- reviewing budgets, contracts, and proposals
- ensuring timely and appropriate standard operating procedures (SOPs) and Quality Assurance Project Plan (QAPP) updates
- securing funding for present and future network needs

Environmental Health Program Supervisor/ Quality Assurance Coordinator (EHPS/QAC). The EHPS/QAC reports to the AMM and is responsible for coordinating and implementing the activities of the monitoring program. The EHPS/QAC's duties include the following:

- collecting, verifying, and reporting data
- assessing the effectiveness of the network system
- ensuring training availability and utilization

- responding to Public Records Requests

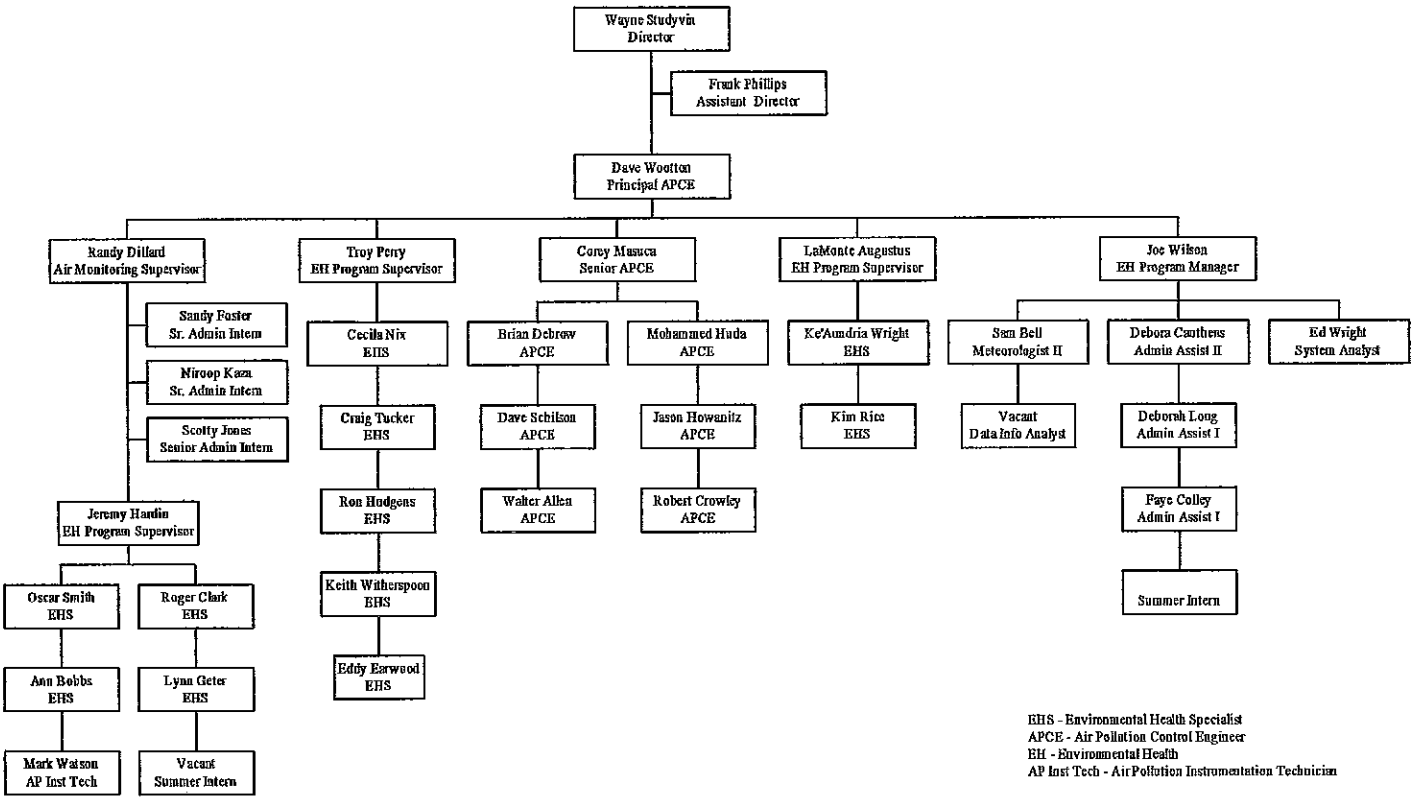
Meteorologist. The Meteorologist reports to the EHPM/QAM of the ARPD and is responsible for coordinating the modeling activities. The Meteorologist's duties include the following:

- generate, and evaluate air quality models

- document position statements developed from modeling activities; outreach and forecasting air quality

Figure 4-1. Ambient Air Quality Monitoring Program Organizational Structure

Jefferson County Department of Health
Environmental Health Services
Air and Radiation Protection Division
September 30, 2006



4.2. Regional Offices

Quality Director. The Quality Director has direct access to the Director on all matters relating to the Department's operation. The Quality Director's duties include:

- assuring that Department policies are maintained at the Regional Office level;
- approving Department Standard Operation Procedures (SOP) and QA Plans.
- Verifying implementation of quality programs.

Regional Administrators. Regional administrators report directly to the director. Regional administrators have the overall responsibility of ensuring the implementation of the QA Program at the regional level. They direct the activities of the regional air quality managers.

Regional Air Quality Managers. The regional air quality managers report directly to the regional administrators and are directly responsible for the activities of the monitoring program staff at the regional offices. Their responsibilities include:

- coordinating and reviewing the collection of environmental data,

- acquiring resources and maintaining budgets pertinent to the collection of environmental data,

- implementing JCDH's QA Program within the region,
- acting as conduits for information to regional monitoring staff,

- training staff in the requirements of QAPPs, and

- ensuring that monitoring personnel follow the QAPPs.

Regional Monitoring Staff. The regional monitoring staff's duties include:

- ensuring that monitoring programs incorporate QA elements of SOPs and QAPPs;

- reviewing environmental data prior to submittal;

- assisting in the acquisition of resources and maintenance of equipment and inventories;
- collecting, calculating, and reviewing environmental data;

- participating in training and certification activities;

- verifying that all required QC activities are performed and that measurement quality objectives are met as prescribed in the QAPP;

- documenting deviations from established procedures and methods;

- reporting nonconforming conditions and corrective actions to the regional air manager, and the Quality Director;

- assessing data quality and flagging suspect data; and

- preparing reports for the Air Quality Monitoring Section.

4.3. Administration Division

- providing support for agency databases and data reporting through the Air Quality System (AQS) database.

Quality Director. The Quality Director has direct access to the Director and has the responsibility and authority to:

- develop, administer and maintain the Quality Management Plan;
- approve QA Plans and implementing procedures;
- assure that quality assurance project plans are established and effectively implemented for each project as applicable;

- assure that appropriate implementing procedures for quality related activities not addressed in quality assurance project plans are documented, approved, and implemented;
- identify quality problems and initiate action which results in solutions;
- verify implementation of the Quality Management Plan and subtier implementing quality assurance project plans and procedures;
- stop work when that work is not meeting JCDH's quality requirements.

4.4. Alabama Department of Environmental Managenent's (ADEM) Technical Services

Administrator. The administrator of the ADEM's Technical Services has direct access to the PAPCE and the AMM on all matters relating to ARPD's operation. The administrator's duties include:

- managing and reviewing grants, budgets, proposals, and allocation of resources;
- purchasing equipment and issuing contracts necessary for the implementation of monitoring programs; and
- providing support for data reporting through the AQS database.

Discipline Lead for Data/GIS Applications. The discipline lead responsible for Data/GIS Applications reports directly to the administrator of Technical Services. Their duties include directing the activities and overseeing training and certification of personnel responsible for the input of environmental data to the GIS database.

Data Entry Specialist. The data entry specialist inputs environmental data to the AQS database and participates in training and certification programs to keep current on technology.

Discipline Lead for Modeling and Analysis. The discipline lead responsible for Modeling and Analysis reports directly to the administrator of Technical Services. Their duties include directing air quality modeling and analysis, and overseeing training and certification of personnel responsible for the input of environmental data to the AQS database.

Air Monitoring. The State's Air Monitoring Manager oversees ADEM's ambient air monitoring network and manages quality assurance and data submittal into the U.S. Environmental Protection Agency's (EPA) AQS database. The modeling analyst also participates in training and certification programs.

4.5. Particulate Matter (PM) Laboratory

PM Laboratory. The Laboratory Analyst in the PM Laboratory is responsible for tracking service agreements, performing laboratory and analytical services in compliance with the PM Laboratory Quality Plan and adheres to the guidance and protocols prescribed by QAPPs and SOPs for laboratory activities.

Laboratory Analyst. The Laboratory Analyst reports directly to the EHPS/QAC. The Laboratory Analyst's duties include:

- coordinating the activities of the laboratory;

- ensuring the implementation of laboratory SOPs and sections of QAPPs as they pertain to filter processing;
- preparing and updating laboratory SOPs and good laboratory practices documents;
- verifying all required QA activities are performed and that measurement quality standards are met;
- maintaining QA records, flagging suspect data, and assessing and reporting on laboratory data quality;
- performing and documenting all maintenance of laboratory equipment;
- preparing and delivering data to the AQS;
- providing training and certification to the laboratory; and
- providing performance audit services for monitoring networks.

5. PROBLEM DEFINITION AND BACKGROUND

In 1970 the Clean Air Act was signed into law. The Clean Air Act and its amendments provide the framework for protecting air quality. In order to protect air quality, active environmental data collection operations must be established and operated in a manner that assures the most applicable and highest quality data are collected. Ambient air quality monitoring programs monitor criteria pollutants (particulate matter [particles with an average aerodynamic diameter of 10 micrometers or less (PM_{10}) or 2.5 micrometers or less ($PM_{2.5}$)], sulfur dioxide [SO_2], carbon monoxide [CO], nitrogen dioxide [NO_2], ozone [O_3], and lead [Pb]). The National Ambient Air Quality Standards (NAAQS) establish limits for each of these pollutants, as shown in Table 5-1.

Table 5-1. National Ambient Air Quality Standards

Pollutant	Standard Value [a]		Standard Type
Carbon Monoxide (CO)			
8-hour average	9 ppm [b]	(10 mg/m^3)	Primary
1-hour average	35 ppm	(40 mg/m^3)	Primary
Nitrogen Dioxide (NO^2)			
Annual Arith. Mean	0.053 ppm	(100 ug/m^3)	Primary and Secondary
Ozone (O_3)			
8-hour average	0.08 ppm	(235 ug/m^3)	Primary and Secondary
1-hour average	.012 ppm	(157 ug/m^3)	Primary and Secondary
Lead (Pb)			
Quarterly Average	1.5 ug/m^3		Primary and Secondary
Particulate Matter (PM_{10}) *Particulates with diameters of 10 micrometers or less*			
24-hour Average	150 ug/m^3		Primary and Secondary
Particulate Matter ($PM_{2.5}$) *Particulates with diameters of 2.5 micrometers or less*			
Annual Arith. Mean	15 ug/m^3		Primary and Secondary
24-hour Average	35 ug/m^3		Primary and Secondary
Sulfur Dioxide (SO_2)			
Annual Arith. Mean	0.03 ppm	(80 ug/m^3)	Primary and Secondary
24-hour Average	0.14 ppm	(365 ug/m^3)	Primary and Secondary
3-hour Average	0.50 ppm	(1300 ug/m^3)	Primary and Secondary

[a] Parenthetical value is an approximately equivalent concentration.
[b] Parts per million

US EPA regulations require all projects involving the generation, acquisition, and use of environmental data be planned, documented and have an approved QAPP. The QAPP is the critical planning document for any environmental data collection operation because it documents how QA and quality control (QC) activities will be implemented during the project's life cycle.

The JCDH's *Quality Assurance Plan* was developed in the *1980's* to implement QA and QC policies and procedures. It is reviewed annually and revised as needed, subject to approval of the EPA's Region 4 QA Officer. The Ambient Air Quality Monitoring Program's QAPP, developed in 2007, is the latest revision to this base document. The QAPP incorporates standard procedures to be followed in all air monitoring projects. JCDH's programs will adhere to the principles and procedures herein, unless a special project requires more stringent requirements.

This document presents the state of JCDH's Ambient Air Quality Monitoring Program's QAPP. The purpose of the Ambient Air Quality Monitoring Program's QAPP is to prescribe requirements, procedures, and guidelines for JCDH's Ambient Air Quality Monitoring QA Program. It is intended to serve as a reference document for implementing and expanding the QA program and provides detailed operational procedures for measurement processes used by the Air Monitoring Section. The QAPP should be particularly beneficial to operators, project officers, and program managers responsible for implementing, designing, and coordinating air pollution monitoring projects. The QAPP is a compilation of QA requirements, procedures, and guidelines that are applicable to air pollution and meteorological measurements systems. They are designed to achieve a high percentage of valid data samples (>90%) while maintaining integrity and accuracy. This QAPP clearly and thoroughly establishes QA protocols and QC criteria required to successfully implement and maintain the JCDH's Ambient Air Quality Monitoring program. The monitoring program is administered by the Air Monitoring Manager. It is the responsibility of the EHPS/QAC to ensure that the quality assurance programs for the field, laboratory, and data processing phases of the monitoring program are implemented.

Quality assurance is a system of management activities designed to ensure that the data produced by the operation will be of the type and quality needed and expected by the data user. Quality control defines the procedures implemented to assure that acceptable precision, bias, completeness, representativeness, and comparability are obtained and maintained in the generated data set. Quality control procedures, when properly executed, provide data that meet or exceed the minimally acceptable quality criteria established to assist management in making confident decisions. It is the policy of JCDH to implement a QA program and QC procedures to assure that data of known and acceptable precision, bias, completeness, comparability, and representativeness are collected in all monitoring projects.

Precision, bias, completeness, comparability, and representativeness are the principle Data Quality Indicators (DQI) that provide qualitative and quantitative descriptions used in interpreting the degree of acceptability of data. "Establishing acceptance criteria for these DQIs sets quantitative goals for the quality of data generated in the analytical measurement process. Of the five principal DQIs, precision and bias are the quantitative measures, representativeness and comparability are qualitative, and completeness is a combination of both qualitative and quantitative measures." (US EPA QA/G-5, Appendix D) Definitions of the DQIs are provided in Section 7.2.

While most people are familiar with accuracy, accuracy is a combined metric that represents the closeness of an individual measurement, or the average of a number of measurements, to the true value. Components of accuracy are random error, represented by the metric precision, and systematic error, represented by the metric bias. These error components result from sampling and analytical operations.

The specific requirements of these five DQIs are established beforehand, on a project by project basis, so that the goals of each project are met. The goal is to locate and eliminate or minimize bias, so the data collected show the true conditions of the area being sampled. This includes consideration of siting criteria, spatial scales, monitoring objectives, climatic change, source configuration, and duration of study.

6. PROJECT/TASK DESCRIPTION

6.1. Description of Work to be Performed

This QAPP was developed to ensure that JCDH's air monitoring network collects ambient and meteorological data that meet or exceed EPA quality assurance requirements. This data is entered into the EPA AQS database.

The work required to collect, document, and report this data includes, but is not limited to:

- establishing a monitoring network that has:
    - appropriate density, location, and sampling frequency;
    - applicable chemical species monitors;
    - associated meteorological monitoring; and
    - accurate and reliable data recording equipment, procedures, and software.
- developing encompassing documentation for:
    - data and report format, content, and schedules;
    - quality objectives and criteria; and
- standard operating procedures providing activities and schedules for:
    - equipment operation and preventative maintenance and
    - instrument calibrations, zero, and span, and precision and accuracy evaluations.
- establishing assessment criteria and schedules.

6.2. Field Activities

Air monitoring personnel will perform those activities that support continued successful operation and expansion of the countywide ambient air quality monitoring network. Air monitoring personnel will perform field activities that include, but are not necessarily limited to, conducting periodic preventative maintenance and servicing equipment located at SLAMS, NAMS, Special Purpose Monitoring Station (SPMS), and Photochemical Monitoring Stations (PAMS) sites located within Jefferson County, Alabama. Operational servicing activities may include, but may not be limited to, collecting samples, recording pertinent field data, and restocking consumables, such as strip chart paper and calibration gases, at the monitoring sites. Additional field activities include relocating sites and/or locating suitable monitoring sites for posslaboratorye expansion of the network.

6.3. Laboratory Activities

Laboratory personnel will perform those activities that support continued successful operation of the statewide ambient air quality monitoring network. Additionally, where analysis of samples is required, the laboratory personnel shall perform those duties such that the data quality provided meets or exceeds EPA QA requirements. Laboratory personnel shall be responsible for preparing consumables for field use. This may include, but not be limited to, performing assays on materials prior to and after exposure to the ambient atmosphere, preparing and analyzing control samples, maintaining consumable inventories, shipping and receiving activities, and performing instrument audits.

6.4. Project Assessment Techniques

An assessment is an evaluation process used to measure the performance or effectiveness of a system and its elements. As used here "assessment" is and all-inclusive term used to denote any of the following: audit, performance evaluation, management systems review (MSR), peer review, inspection, or surveillance. Section 20 will discuss the details of assessments. Information on the parties implementing assessments and their frequency is provided in Table 6-1.

6.5. Project Records

JCDH will establish and maintain procedures for the timely preparation, review, approval, issuance, use, control, revision, and maintenance of documents and records. The categories and types of records and documents which are applicable to document control for ambient air quality information are presented in Table 6-2. Information on key documents in each category is explained in more detail in Section 9.

Table 6.1. Assessment Schedule

Assessment Type	Assessment Agency	Frequency
Technical System Audit	EPA Region 4 JCDH	Every 3 Years
Network Review	EPA Region 4 ADEM	Annually
Data Qualifiers/Flags Review	JCDH	Annually
Standard Operating Procedures Reviews	EPA Region 4	Annually
Data Quality Assessment	JCDH	Annually
$PM_{2.5}$ Performance Evaluation Program	EPA Designated Contractor	25% of sites per year/4 times per year
National Performance Audit Program	EPA Designated Contractor	As Scheduled

Table 6.2. Critical Documents and Records

Categories	Record/Document Type
Site Information	Network Descriptions Site Files Site Maps Site Pictures
Environmental Data Operations	Quality Assurance Project Plans Standard Operating Procedures Field and Laboratory Notebooks Sample Handling/Custody Records Inspection/Maintenance Records
Raw Data	Any Original Data (routine and quality control) Including Data Entry Forms
Data Reporting	Air Quality Index Reports Annual SLAMS Report Data/Summary Reports
Data Management	Data Algorithms Data Management Plans/Flowcharts Data Management Systems
Quality Assurance	Gook Laboratory Practices Network Reviews Control Charts Data Quality Assessments Quality Assurance Reports Technical System Audits Response/Corrective Action Reports Site Audits

7. DATA AND MEASUREMENT QUALITY OBJECTIVES AND CRITERIA

The material presented in the QAPP is an "ideal" QA program for air pollution measurement systems. A special project may require different procedures depending on the purpose and scope of the project, resulting in a QAPP specific to that project that addresses the QA areas or elements as required.

However, the specific written procedures or methodologies for operating instruments and handling data, must be adhered to by all individuals, firms, or agencies producing air quality data for enforcement purposes or under the terms of an air quality permit. Preferably, the designated methodologies shall comply with EPA approved Federal Reference Methods (FRM), or equivalent methods.

7.1. Data Quality Objectives

This section provides a description of the data quality objectives (DQO) for the ambient air quality monitoring program for JCDH. Data quality objectives are qualitative and quantitative statements that:

- clarify the intended use of the data,
- define the type of data needed, and
- specify the tolerable limits on the probability of making a decision error due to uncertainty in the data.

In general, the goal of the Ambient Air Quality Monitoring Program is to:

- determine the highest concentrations expected to occur in the area covered by the network;
- determine representative concentrations in areas of high population density;
- determine the impact on ambient pollution levels of significant sources or source categories;
- determine the general background concentration levels;
- determine the extent of regional pollutant transport among populated areas, and in support of secondary standards; and
- determine the welfare-related impacts in rural and remote areas (such as visibility impairment and effects on vegetation).

7.1.1. Intended Use of Data

This data will be used to:

- establish an historical baseline concentration of natural and anthropogenic air pollutants,
- monitor the current dynamic concentrations of these air pollutants,
- evaluate compliance with the NAAQS,
- monitor progress made toward meeting ambient air quality standards,
- activate emergency control procedures that prevent or alleviate air pollution episodes,
- provide data upon which long term control strategies can be reliably developed,

- observe pollution trends throughout the region, and
- provide a database for researching and evaluating effects.

7.1.2. Type of Data Needed

The data compiled is a combination of meteorological and criteria pollutant data. The criteria pollutants, established by EPA (particulate matter [$PM_{2.5}$ and PM10], SO_2, CO, NO_x, O_3, and Pb), are monitored at the designated SLAMS, NAMS, SPMS, and PAMS. Specific information on the sampling design, including how to identify monitoring locations, is presented in Section 10.

7.1.3. Tolerable Error Limits

In the development of the EPA model QAPP for $PM_{2.5}$, EPA utilized the formal DQO process (see: *Guidance for the Data Quality Objectives Process,* EPA QA/G-4, EPA/600/R-96/055, September 1994) to specify tolerable limits on the probability of making a decision error due to uncertainty in the data. That is, limits on the probability of coming up with false positive or false negative error. A false positive error is encountered when the data indicate that an emissions limit has been exceeded when in fact, due to errors in the data, it has not been exceeded. Alternately, a false negative error is encountered when the data indicate that no emissions limit has been exceeded when in fact, due to errors in the data, an emissions limit has been exceeded. Utilizing the DQO process, will determine the objectives regarding the quality of the ambient air measurement system to control precision and bias in order to reduce the probability of decision errors. The Ambient Air Quality Monitoring Program will establish an acceptable precision of 15%, as measured by coefficient of variation, and an acceptable bias of ±15%. By controlling precision and bias at these levels, the decision error probability limit will be 95%.

7.2. Measurement Quality Objectives

As air pollution and meteorological measurement systems increase in both cost and complexity, it becomes essential that have a methodology that will, in a cost-effective manner, increase the completeness and precision and decrease the bias of the data produced by the JCDH's measurement systems.

Once a DQO is established, the quality of the data must be evaluated and controlled to ensure that it is maintained within the established acceptance criteria. Measurement quality objectives (MQOs) are designed to evaluate and control various phases (sampling, preparation, analysis) of the measurement process to ensure that total measurement uncertainty is within the range prescribed by the DQOs. The MQOs for JCDH's Ambient Air Quality Monitoring Program will be defined in terms of the following DQI:

- ***Precision*** - "Precision is a measure of agreement between two replicate measurements of the same property, under prescribed similar conditions. This agreement is calculated as either the range or as the standard deviation." (US EPA QA/G-5, Appendix D) This is the random component of error.
- ***Bias*** - "Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction." (US EPA QA/G-5, Appendix D) Bias is determined by estimating the positive and negative deviation from the true value as a percentage of the true value.

- ***Comparability*** - "Comparability is the qualitative term that expresses the confidence that two data sets can contribute to a common analysis and interpolation. Comparability must be carefully evaluated to establish whether two data sets can be considered equivalent in regard to the measurement of a specific variable or groups of variables." (US EPA QA/G-5, Appendix D)
- ***Representativeness*** - "Representativeness is a measure of the degree to which data accurately and precisely represent a characteristic of a population parameter at a sampling point or for a process condition or environmental condition. Representativeness is a qualitative term that should be evaluated to determine whether in situ or other measurements are made and physical samples collected in such a manner that the resulting data appropriately reflect the media and phenomenon measured or studied." (US EPA QA/G-5, Appendix D)
- ***Completeness*** - Completeness is a metric quantifying the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct, normal conditions. Completeness can be expressed as a ratio or a percentage. Data completeness requirements are included in the reference methods (40 CFR Part 50).

For each of these attributes, acceptance criteria have been developed using various parts of 40 CFR and EPA supplied guidance documents. The MQOs for JCDH's Ambient Air Quality Monitoring Program are listed in Tables 7-1 through 7-8. More detailed descriptions of these MQOs and how they will be used to control and assess measurement uncertainty are described in other elements, as well as in the SOPs of this QAPP.

Table 7-1. Nitrogen Oxides Measurement Quality Objectives.
Measurement Quality Objective Parameter –Nitrogen Dioxide (NO_2) (Chemiluminescence).

Requirement	Frequency	Acceptance Criteria	Reference	Information/Action
Standard Reporting Units	All data	Ppm[a]	40 CFR, Pt 50.11	
Shelter Temperature Temperature range Temperature control	 Daily Daily	 20 to 30 °C ± 2 °C	 40 CFR, Pt 53.20 Vol. II, S 7.1 1/ Vol. II, MS 2.3.2	Instruments designated as reference or equivalent have been tested over this temperature range. Maintain shelter temperature above sample dew point. Shelter should have a 24-hour temperature recorder. Flag all data for which temperature range or fluctuations are outside acceptance criteria.
Equipment NO_2 analyzer Air flow controllers Flow meters	 Purchase specification	 Reference or equivalent method Flow rate regulated to ± 2% Accuracy ± 2%	 40 CFR, Pt 53.9 40 CFR, Pt 50, App F, 52.2 EPA-600/4-75-003	
Detection Noise Lower detectable level	 Purchase specification	 0.005 ppm 0.01 ppm	 40 CFR, Pt 53.20 and .23 40 CFR, Pt 53.20 and .23	Instruments designated as reference or equivalent have been determined to meet these acceptance criteria
Completeness Hourly data	Quarterly	75%	40 CFR, Pt 50.11	
Compressed Gases Dilution gas (zero air)	Purchase specification	Free of contaminants	EPA-600/4-75-003	Return cylinder to supplier.
Gaseous standards	Purchase specification	NIST[b] traceable (e.g., EPA protocol gas)	40 CFR, Pt 50, App F, S 1.3 EPA-600/R-97/121	Nitric oxide in nitrogen EPA protocol gases has a 24-month certification period and must be recertified to extend the certification.

[a]-parts per million
[b]-National Institute of Science and Technology

Measurement Quality Objective Parameter – Nitrogen Dioxide (NO_2) (Chemiluminescence) – Continued

Requirement	Frequency	Acceptance Criteria	Reference [a]	Information/Action
Calibration				
Multipoint calibration (at least 5 points)	1calibration every 6 months, after failure of QC check or after maintenance.	Residence time 2 mm Dynamic Parameter 2.75 ppm-mm	40 CFR, Pt 50, App F, S 1 Vol. II, S 12.6 Vol. II, MS 2.3.2	Zero gas and at least four upscale calibration points. Points outside acceptance criterion are repeated. If still outside consult manufacturers manual and invalidate data to last acceptable multipoint calibration or zero/span check.
Converter efficiency	During multipoint calibrations	All points within ± 2% of full scale of best-fit straight line 96%	40 CFR, Pt 50, App F	Replace or service converter.
Zero/span check- level 1	1 calibration every 2 weeks	Zero drift ± 20 to 30 ppb Span drift ± 20 to 25%	Vol. II, MS.2.3.2 Vol. II, S 12.6 Vol. II, MS 2.3.2	If calibration factors are updated after each zero/span, invalidate data to last acceptable zero/span check, adjust analyzer, and perform multipoint calibration.
Flow meters	1calibration every 3 months	Zero drift ± 10 to 15 ppb Span drift ± 15 °C Accuracy ±2%	Vol. II, S 12.6 Vol. II, MS 2.3.2 Vol. II, App 12	If fixed calibration factors are used to calculate data, invalidate data to last acceptable zero/span check, adjust analyzer, and perform multipoint calibration. Flow meter calibration should be traceable to NIST standards.
Performance Evaluation				
NPAP [b]	1/year at selected sites	Mean absolute difference 15%	NPAP QAPP	Use information to inform reporting agency for corrective action and technical systems audits.
State audits	1/year	State requirements	Vol II, App 15, 5 3	
Precision				
Single analyzer	1 calibration every 2 weeks	None 95% Confidence Interval ± 15%	40 CFR, Pt *58*, App A EPA-600/4-83-023 Vol II, App 15, S6	Concentration = 0.08-0.10 ppm.
Reporting organization	1calibration every 3 months			
Accuracy				
Single analyzer Reporting organization	25% of sites quarterly (all sites yearly)	None 95% Confidence Interval ± 20%	40 CFR, Pt *58*, App A EPA-600/4-83-023 Vol II, App 15, S3	Four concentration ranges. If failure, recalibrate analyzer and reanalyze samples. Repeated failure requires corrective action.

Reference refers to the *QA Handbook for Air Pollution Measurement Systems*, Volume I I. The use of "S" refers to sections within Part 1 of Volume I I. The use of "MS" refers to method-specific sections in Volume II.

[b] - National Performance Audit Program

Table 7-2. Ozone Measurement Quality Objectives.
Measurement Quality Objective Parameter – Ozone (O_3) (Ultraviolet Photometric).

Requirement	Frequency	Acceptance Criteria	Reference	Information/Action
Zero Air	Purchase specification	Free of O_3 or any substance that might react with O_3 (e.g., NO, NO_2, hydrocarbons, and particulate)	EPA-600/4-79-057	Return cylinder to supplier
Ozone Analyzer Calibration				**If calibration updated at each zero/span,** invalidate data to last acceptable check, adjust analyzer, perform multipoint calibration.
Zero/span check -level 1	1 calibration every 2 weeks	Zero drift ± 20 to 30 ppb Span drift ± 20 to 25%	Vol. II, S 12.6 Vol. II, S 12.6	**If flied calibration used to calculate data,** invalidate data to last acceptable check, adjust analyzer, perform multipoint calibration.
		Zero drift ± 10 to 15 ppb Span drift ± 15%	Vol. II, S 12.6 Vol. II, S 12.6	
Multipoint calibration (at least *5* points)	Upon receipt, adjustment, or 1 calibration every 6 months	Linearity error < 5%	40 CFR, Pt 50, App D, S 5.2.3 EPA-600/4-79-057 S.5 Vol. II, S 12.2	Zero gas and at least four upscale calibration points. Check Verify accuracy of flow dilution. Redo analysis. If failure persists corrective action required.
Performance Evaluation				
NPAP [b]	I year at selected sites	Mean absolute difference 15%	Vol. II, S 16.3	Use information to inform reporting agency for corrective action and technical systems audits.
State audits	1/year	State requirements	Vol. II, App 15, S 3	
Precision				
Single analyzer	1 calibration every 2 weeks	None	40 CFR, Pt *58,* App A	Concentration = 0.08-0.10 ppm.
Reporting organization	1 calibration every 3 months	*95%* CI <± 15%	EPA-600/4-83-023 Vol. II, App 15, S 6	
Accuracy				
Single analyzer	25% of sites quarterly (all sites yearly)	None	40 CFR, Pt *58,* App A	Four concentration ranges. If failure, recalibrate and reanalyze. Repeated failure requires corrective action.
Annual accuracy		95% CI ± 20%	EPA-600/4-83-023 Vol. II, App 15, S 6	

[a] - Reference refers to the *QA Handbook for Air Pollution Measurement Systems,* Volume I I. The use of "S" refers to sections within Part 1 of Volume I I. The use of "MS" refers to method-specific sections in Volume II.

[b] - National Performance Audit Program

Measurement Quality Objective Parameter – Ozone (O_3) (Ultraviolet Photometric) – Continued

Requirement	Frequency	Acceptance Criteria	Reference	Information/Action
Standard Reporting Units	All data	ppm	40 CFR, Pt 50.9	
Shelter Temperature Temperature range Temperature control	Daily Daily	20 to 30 °C. ± 2 °C	40 CFR, Pt. 53.20 Vol II, S 7.1 [a]	Instruments designated as reference or equivalent have been tested over this temperature range. Maintain shelter temperature above sample dew point. Shelter should have a 24-hour temperature recorder. Flag all data for which temperature range or fluctuations are outside acceptance criteria.
Equipment O_3 analyzer	Purchase specification	Reference or equivalent method	40 CFR, Pt 53.9 EPA-600/4-79-057	Airflow controllers must be capable of regulating air flows as necessary to meet the output stability and photometer precision requirements. The photometric measurement of absorption is not directly related to flow rate, but may be indirectly related due to thermal or other effects.
Detection Noise Lower detectable level	Purchase specification	0.005 ppm 0.01 ppm	40 CFR, Pt 53.20 and .23 40 CFR, Pt 53.20 and .23	Instruments designated as reference or equivalent have been determined to meet these acceptance criteria.
Completeness (seasonal) Maximum 1-hour Concentration	Daily	75% values from 9:01 AM to 9:00 PM (Local Standard Time)	40 CFR, Pt 50, App H, S3	A missing daily maximum ozone value may be assumed to be less than the standard if valid daily maxima on the preceding and following days do not exceed 75% of the standard.
Transfer Standard Qualification and Certification Re-certification to local Primary standard	Upon receipt of transfer standard 1calibraion every 3 months (if at a fixed site)	± 4% or ± 4 ppb (whichever greater) RSD[b] of six slopes 3.7% Std. dev. Of six intercepts 1.5% New slope = ± 0.05 of previous	EPA-600/4-79-056 EPA-600/4-79-057 EPA-600/4-79-057 EPA-600/4-79-057	Six comparison runs that include, at minimum, six concentrations per comparison run including 0 and 90 ± 5% of upper range. A single six-point comparison run.
Local Primary Standard Certification/Re-certification to Standard Photometer (if re-certified via a transfer Standard)	1/year 1/year	Difference ±5% (preferably ±3%) Regression slopes = 1.00 ± 0.03 and two intercepts are 0 ± 3 ppb	*Determination of Ozone by Ultraviolet Analysis (draft)*	The local primary standard is a standard in its own right, but it must be repaired and recertified if the acceptance criterion is exceeded.
EPA Standard Reference Photometer Re-certification	1/year	Regression slope =1.00 ± 0.01 and intercept <3 ppb	Protocol for Re-certification of Standard Reference Photometers. (TRC Environmental Document)	Nine replicate analysis over 12 concentration ranges. Disagreement must be resolved. EPA Standard Reference Photometer rechecked with NIST[c]. If OK, network standard reference photometer must be repaired.

[a]-Reference refers to the *QA Handbook for Air Pollution Measurement Systems*, Volume I I. The use of "S" refers to sections within Part 1 of Volume I I. The use of "MS" refers to method-specific sections in Volume II.

[b]-Relative Standard Deviation

[c]-National Institute of Science and Technology

Table 7-3. Lead (Pb) MQO.
MQO - Parameter Lead (Atomic Absorption Spectroscopy).

Requirement	Frequency	Acceptance Criteria	Reference	Information/Action
Reporting Units	All data	µsg/m^3	40 CFR, Pt 50.12	
Filter Checks				
Visual defect check	All filters	See reference	Vol. II, MS 2.2.4	Discard any defective filters
Filter Integrity				
Collection efficiency	Purchase specification	99%	40 CFR, Pt 50, App B, S 7.1	Measure using DOP test (ASTM-2988). Reject shipment
Integrity		2.4mg max weight loss	"	
pH		6 to I0	"	
Equipment				
Sampler	Purchase specification	Reference or equivalent method	40 CFR, Pt *53.9* 40 CFR, Pt 50, App B, S 7	
Flow rate transfer Standard	Purchase specification	0.02 std. m^3/min	"	
Detection Limit				This value is based on a collaborative test of the method. Assumed air volume of 2,400 m^3.
LDL	Not applicable	0.07 g/m^3	40 CFR, Pt 50, App G, S 2	
Completeness	Quarterly	75%		
Sampler calibration				
Orifice calibration unit (flow rate transfer standard)	On receipt and yearly	Indicated flow rate within ± 2% of actual flow rate	Vol. II, MS 2.8.1 Vol. II, MS 2.2.2	Adopt a new calibration curve. A rotary-type, gas displacement meter is the recommended NIST-traceable reference standard.
Elapsed time meter	On receipt and 1/6 months	± 2 min/24 hours	"	Adjust or replace meter.
On/Off Timer	On receipt and 1/3 months	± 30 min/24 hour	Vol. II, MS 2.2.2	Checked against elapsed time meter. Adjust or repair.
Sampler flow rate	On receipt, if audit deviation >7 %, after maintenance	All points within ± *5* % of full scale of best-fit straight line	"	Rerun points outside limits until acceptable.

MQO – Parameter Lead (Atomic Absorption Spectroscopy) – Continued

Requirement	Frequency	Acceptance Criteria	Reference	Information/Action
Analytical calibration Reproducibility test	On receipt	5%	Vol. II, MS 2.8.1	Reproducibility = 100 ([high response-low response]/average response). Responses should be corrected for the blank level. If acceptance criterion is exceeded, instrument should be checked by a rep or qualified operator.
Calibration stability	Before 1st sample, after every 10th sample, after last sample	± 5 % deviation from calibration curve,	Vol. II, MS 2.8.5	Alternate between two control standards with concentrations 1 µg/mL or 1 to 10 µg/mL. Take corrective action and repeat the previous ten analyses.
Performance Evaluation (NPAP)	1/yr at selected sites	Mean absolute difference 15%	Vol. II, S 16.3 40 CFR, Pt 58, App A	Use information to inform reporting agency for corrective action and technical systems audits
Sampler performance Audit (flow rate)	1/3 months	Percentage difference ± 7%	Vol. II, MS 2.2.8	Recalibrate before any additional sampling
Precision Single analyzer	1/6 days	None	40 CFR, Pt 58, App A, S 5.3	Both lead values must be > 0.15 µg/m^3
Reporting Organization	1/3 months	95% CI <± 15%	40 CFR, Pt 58, App A, S 5.3	
Accuracy Single analyzer	25 % of sites quarterly	Percentage difference ± 16%	Vol. I I, MS 2.8.8 40 CFR, Pt 58, App A, S 3.4	Analyze three audit samples in each of the two concentration ranges. The audit samples shall be distributed as much as possible over the entire calendar quarter.
Reporting organization		95% CI ± 20%	EPA-600/4-83-023	

-reference refers to the QA Handbook for Air Pollution Measurement Systems, Volume II. The use of "S" refers to sections within Part 1 of Volume II. The use of "MS" refers to method-specific sections in Volume II.

Table 7-4. PM_{10} Measurement Quality Objectives.
Measurement Quality Objectives

Requirement	Frequency	Acceptance Criteria	Reference	Information/Action
Reporting Units	All data	~sg/m^3	40 CFR, Pt 50.7	
Filter Checks				
Visual defect check	All filters	See reference	Vol I I, MS 2.10.4	Discard any defective filters.
Filter integrity				
collection	Purchase	99%	40 CFR, Pt 50, App M, S 7.2	As measure by DOP test (ASTM-2988). Reject shipment.
Efficiency	specification	± 5 µg/m^3	40 CFR, Pt 50, App M, S 7.2	
Integrity		<25.0 microequivalents/gram	40 CFR, Pt 50, App M, S 7.2	Following two months storage at ambient temp and relative humidity. Reject filters.
Alkalinity	All filters			
Filter Conditioning	All filters	At least 24 hours	40 CFR, Pt 50, App M, S 9.3	Repeat equilibration.
Equilibration time	All filters	15 to 30 C	40 CFR, Pt 50, App M, S 7.4	Keep thermometer in balance room and record temperature daily.
Temperature range	All filters	± 3 C	40 CFR, Pt 50, App M, S 7.440	
Temperature	All filters	20 to 45% relative humidity	CFR, Pt 50, App M, S 7.440	Keep hygrometer in the balance room and record humidity daily.
Control		± 5% relative humidity	CFR, Pt 50, App M, S 7.4	
Humidity range				
Humidity control				
Equipment				
Sampler	Purchase specification	Reference or equivalent method	40 CFR, Pt 53.9	
Flow rate transfer	Purchase	± 2 % accuracy	40 CFR, Pt 50, App M, S7.3	
Standard	specification	(NIST traceable)		
Analytical balance	Purchase specification	Sensitivity = 0.1 mg	40 CFR, Pt 50, App M, S 7.5	This acceptance criterion is inconsistent with other acceptance criteria for balance that are in the quality assurance handbook.
Mass reference		NIST traceable	Vol. II, MS 2.10.4	
Standards		(e.g., ANSI/ASTM Class 2)	Vol. II, MS 2.10.4	
Detection Limit				
Lower Detectable Limit	Not applicable	Not applicable	40 CFR, Pt 50, App M, S 3.1	The lower limit of the mass concentration is determined by the repeatability of filter tare weights, assuming the nominal air sample volume for the sampler.
Completeness	Quarterly	75%	40 CFR, Pt 50, App K, S 2.3	

PM_{10} Measurement Quality Objectives -- Continued

Requirement	Frequency	Acceptance Criteria	Reference	Information/Action
Sampler Calibration				
Flow control device	On installation, after repairs, after out-of-limits flow check	<4% difference from manufacturers spec and actual	40 CFR, Pt 50, App M, S 7.1 Vol. II, MS 2.10.2	Adopt new calibration curve if no evidence of damage, otherwise replace.
Elapsed time meter	On receipt and 1 calibration every 6 months	± 15 % of range	40 CFR, Pt 50, App M, S 7.1	Adjust or replace.
Flow rate transfer Standard	Periodically	± 2% over the expected range of ambient conditions	Vol. II. MS2.l0.l 40 CFR, Pt 50, App M S 8.2 Vol. II, MS 2.10.1	Checked against NIST-traceable primary standard.
Balance Calibration	1/year		Vol. II, MS 2.10.4	Calibrate and maintain according to the manufacturer's recommendations.
Performance Evaluation				
NPAP [a]	1/year at selected sites	Mean absolute difference 15%	Vol. II, S 16.3	Use information to inform reporting agency for corrective action and technical systems audits
Precision				
Single analyzer	1 calibration every 6 days	5 g/m^3 for conc. 80 $\mu g/m^3$	40 CFR, Pt 50, App M, S 4.1	Both PM_{10} values must be > 20 $\mu g/m^3$.
Reporting organization	1 calibration every 3 months	7% for conc. >80 $\mu g/m^3$ 95% CI < ± 15%	40 CFR, Pt 58, App A, 55.3 EPA-600/4-83-023	
Accuracy				
Single analyzer Annual accuracy	25% of sites quarterly (all sites yearly)	None 95% CI ± 20%	40 CFR, Pt 58, App A EPA-600/4-83-023 Vol. I I, App 15, S 6	Transfer standards different then those used in calibration. Recalibrate before any additional sampling. Invalidate data to last acceptable flow check if difference > 10%.
QC Checks				
Field calibration flow Check	1/month	Percentage difference ± 7% from samplers indicated flow rate or ± 10% from design condition flow rate	40 CFR, Pt 50, App M, S 8.2 Vol. I I, MS 2.10.3	Trouble shoot and recalibrate sampler.
"Standard" filter weighing	At beginning of weighing day	± 20 g of original weight	Vol. II, S 2.10.4	Trouble shoot and reweigh.
Re-weighing filters	5 exposed and 5 unexposed/day	± 20 g of original weight	Vol. I I,S2.10.4	Trouble shoot and reweigh.
Balance zero and Calibration check	Every fifth filter	± 4 g at zero ± 2 g at 10 mg	Vol. I I, S 2.10.4	Trouble shoot and reweigh.

[a]-National Performance Audit Program

Table 7-5. Sulfur Dioxide Measurement Quality Objectives.
Measurement Quality Objectives Parameter – Sulfur Dioxide (SO_2) (Ultraviolet Fluorescence).

Requirement	Frequency	Acceptance Criteria	Reference	Information/Action
Standard Reporting Units	All data	ppm	40 CFR, Pt 50.4	
Shelter temperature Temperature range Temperature control	Daily Daily	20 to 30 °C ± 2 °C	40 CFR Pt. 53.20 Vol. II S7.I [a] Vol. II, MS 2.9	Instruments designated as reference or equivalent have been tested over this temperature range. Maintain temperature above sample dew point. Shelter should have a 24-hour temperature recorder. Flag all data for which temperature range or fluctuations are outside acceptance criteria.
Equipment SO_2 analyzer Airflow controllers Flow meters	Purchase specification	Reference or equivalent method Flow rate regulated to ± 2% Accuracy ± 2 %	Vol. II, MS 2.9	
Detection Noise Lower detectable level	Purchase specification	.005 ppm .01 ppm	40 CFR, Pt 53.20 and .23 40 CFR, Pt 53.20 and .23	Instruments designated as reference or equivalent have been determined to meet these acceptance criteria.
Completeness Annual standard 24-hour standard 3-hour standard	Quarterly 24 hours 3 hours	75% 75% 75%	40 CFR, Pt 50.43	
Compressed Gases Dilution gas (zero air) Gaseous standards	Purchase specification Purchase specification	SO_2 free, 21% O_2/78% N_2, 300 to 400 ppm CO_2, 0.1 ppm aromatics NIST[b] Traceable (e.g., permeation tube or EPA protocol gas	Vol. II, MS 2.9.2 EPA-600/R97/I2I	Return cylinder to supplier. It is recommended that a clean air system be used instead of compressed air cylinders. Sulfur dioxide in nitrogen EPA protocol gases have a 24-month certification period for concentrations between 40 and 499 ppm and a 36-month certification period for higher concentrations.

Measurement Quality Objectives Parameter – Sulfur Dioxide (SO_2) (Ultraviolet Fluorescence) – Continued

Requirement	Frequency	Acceptance Criteria	Reference	Information/Action
Calibration Multipoint calibration (at least 4 points)	Upon receipt, adjustment, or 1 calibration every 6 months	All points within + 2% of full scale of best-fit straight line	Vol. II, S 12.6 Vol. II, MS 2.9.2	Zero gas and at least three upscale points. Note: two pages from Section 2.4 (Calibration Procedures) of Vol. II, MS 2.9.2 are missing from the 1994 reprinting of the QA Handbook[a].
Zero/span check -level 1	1 calibration every 2 weeks	Zero drift ± 20 to 30 ppb Span drift ± 20 to 25%	Vol. II, S 12.6 Vol. II, S 12.6	**If calibration updated at each zero/span,** invalidate data to last acceptable check, adjust analyzer, perform multipoint calibration **If fixed calibration used to calculate data,** invalidate data to last acceptable check, adjust analyzer, perform multipoint calibration. Flow meter calibration should be traceable to NIST [b] standards
Flow meters	1 calibration every 3 months	Zero drift ± 10 to 15 ppb Span drift ± 15% Accuracy ± 2%	Vol. II, App 12	
Performance Evaluation NPAP [c] State audits	1/year at selected sites 1/year	Mean absolute difference 15% State requirements	Vol. II, S 16.3 Vol. II, App 15, S 3	Use information to inform reporting agency for corrective action and technical systems audits.
Precision Single analyzer Reporting organization	1/2 weeks 1/3 months	None 95% CI <± 15%	40 CFR, Pt 58, App EPA-600/4-83-023 Vol. II, S 16, S2	Concentration = 0.08-0.10 ppm.
Accuracy Annual accuracy check- Reporting organization	25 % of sites quarterly (all sites yearly)	None 95% CI ± 20%	40 CFR, Pt 58, App A EPA-600/4-83-023 Vol. II, S 16	Four concentration ranges. If failure, recalibrate and reanalyze. Repeated failure requires corrective action.

Reference refers to the *QA Handbook for Air Pollution Measurement Systems,* Volume II. The use of "S" refers to sections within Part 1 of Volume II. The use of "MS" refers to method-specific sections in Volume II.

[b] - National Institute of Science and Technology

[c] - National Performance Audit Program

Table 7-6. Carbon Monoxide Measurement Quality Objectives.

Measurement Quality Objectives Parameter – Carbon Monoxide (CO) (Non-Dispersive Infrared Photometry)

Requirement	Frequency	Acceptance Criteria	Reference	Information/Action
Standard Reporting Units	All data	ppm	40 CFR, Pt 50.8	
Shelter Temperature Temperature range Temperature control	 Daily Daily	 20 to 30 °C <± 2 °C	 40 CFR, Pt. 53.20 Vol. II, S 7.1 a	Instruments designated as reference or equivalent have been tested over this temperature range. Maintain shelter temperature above sample dew point. Shelter should have a 24-hour temperature recorder. Flag all data for which temperature range or fluctuations are outside acceptance criteria.
Equipment CO analyzer Flow controllers Flow meters	Purchase specification	Reference or equivalent method Flow rate regulated to ± 1% Accuracy ± 2%	40 CFR, Pt 50, App C	
Detection Limit Noise Lower detectable level	Purchase specification	0.5 ppm 1.0 ppm	40 CFR, Pt 53.20 and .23	Instruments designated as reference or equivalent have been determined to meet these acceptance criteria.
Completeness 8-hour average	Hourly	75% of hourly averages for the 8-hour period	40 CFR, Pt 50.8	
Compressed Gases Dilution gas (zero air)	Purchase specification	<0.1 ppm CO	40 CFR, Pt 50, App C	Return cylinder to supplier.
Gaseous standards	Purchase specification	NIST Traceable (e.g., EPA Protocol as)	EPA-600/R97/I2	Carbon monoxide in nitrogen or air EPA protocol gases have a 36-month certification period and must be re-certified to extend the certification.

Measurement Quality Objectives Parameter – Carbon Monoxide (CO) (Non-Dispersive Infrared Photometry) – Continued

Requirement	Frequency	Acceptance Criteria	Reference	Information/Action
Calibration				
Multipoint calibration (at least 5 points)	Upon receipt, adjustment, or 1 calibration every 6 months	All points within ± 2% of full scale of best-fit straight line Zero drift ± 2 to 3 ppm Span drift ± 20 to 25%	Vol. II, S 12.6 Vol. II, MS.2.6. i	Zero gas and at least four upscale calibration points. Points outside acceptance criterion are repeated. If still outside criterion, consult manufacturer's manual and invalidate data to last acceptable calibration.
Zero/span check-level 1	1 calibration every 2 weeks	Zero drift ± Ito 1.5 ppm Span drift ± 15%	Vol. II, S 12.6	**If calibration updated at each zero/span,** invalidate data to last acceptable check, adjust analyzer, perform multipoint calibration.
		Accuracy ± 2%	Vol. II, 5 12.6	**If fixed calibration used to calculate data,** invalidate data to last acceptable check, adjust analyzer, perform multipoint calibration.
Flow meters	1/3 months		Vol. II, App 12	Flow meter calibration should be traceable to NIST[b] standards.
Performance Evaluation				
NPAP[c]	1/year at selected sites	Mean absolute difference 15%	Vol. II, S 16.3	Use information to inform reporting agency for corrective action and technical systems audits
State audits	1/year	State requirements	Vol. II, pp 15, S 3	
Precision				
Single analyzer	1 calibration every 2 weeks	None	40 CFR, Pt 58, App A EPA-600/4-83-023	Concentration = 8 to 10 ppm. Aggregation of a quarters measured precision values.
Reporting organization	1 calibration every 3 months	95% CI ± 15%	Vol. II, App 15,S5	
Accuracy				
Single analyzer	25% of sites quarterly (all sites yearly)	None	40 CFR, Pt 58, App A	Four concentration ranges. If failure, recalibrate and reanalyze. Repeated failure requires corrective action.
Reporting organization		95% CI ± 20%		

Reference refers to the *QA Handbook for Air Pollution Measurement Systems*, Volume II. The use of "S" refers to sections within Part 1 of Volume II. The use of "MS" refers to method-specific sections in Volume II.

b - National Institute of Science and Technology

c - National Performance Audit Program

Table 7-7. PM2.5 Measurement Quality Objectives. Measurement Quality Objectives Parameter – PM2.5

Requirement	Frequency	Acceptance Criteria	40 CFR Reference	QA Guidance Document 2.12 Reference [e]
Filter Holding Times Pre-exposure Post-exposure weighing	All filters	<30 days before sampling <10 days at 25 °C from sample end date <30 days at 4 °C from sample end date	Part 50, App. L Sec 8.3	Section 7.9 Section 7.11 Section 7.11
Sampling Period	All data	1380-1500 minutes, or value if < 1,380 and exceedance of NAAQS[a]	Part 50, App. L Sec 3.3	
Reporting Units	All data	g/m^3	Part 50.3	Section 11.1
Detection Limit Lower detection limit Upper concentration limit	All data All data	2 g/m^3 200 g/m^3	Part 50, App. L Sec 3.1 Part 50, App. L Sec 3.2	
Sampling Instrument Flow rate Filter temperature sensor	Every 24 hours of operation	± 5% of 16.67 lpm[b] ±2% control volume measured ± 5% average for < 5 min. ± 50 °C of ambient for < 30mm	Part 50, App. L Sec 7.4	
Data Completeness	Quarterly	75%	Part 50, App. N, Sec. 2.1	
Filter Visual defect check Filter conditioning Environment Equilibration Temperature range Temperature control Humidity range Humidity control Pre/post sampling RH[c] Balance	All filters	See reference[e] 24 hours minimum 20-23 °C ± 2 °C SD[d] over 24 hr 30% - 40% RH or + 5% sampling RH but >20%RH ± 5 % SD over 24 hr ± 5 % RH Located in filter conditioning environment	Part 50, App. L Sec 6.0 Part 50, App. L Sec 8.2 Part 50, App. L Sec 8.2 Part 50, App. L Sec 8.2 Part 50, App. L Sec 8.2 Part 50, App. L Sec 8.2 Part 50, App. L Sec 8.3.3 Part 50, App. L Sec 8.3.2	Section 7.5 Section 7.6 Section 7.6 Section 7.6 Section 7.6 Section 7.6
Filter Checks Lot blanks Exposure lot blanks	3 filters per lot 3 filters per lot	Less than 15 g change between weighings Less than 15 g change between weighings	Not described Not described	Section 7.7 Section 7.7
Lab QC Checks Field filter blank Lab filter blank Balance Check Duplicate Filter Weighing	10% or 1 per weighing session 10% or 1 per weighing session Beginning, every 10th sample, end. 1 per weighing session	± 30 g change between weighings ± 15 g change between weighings ± 3 g ± 15 g change between masses	Part 50, App. L Sec 8.3 Part 50, App. L Sec 8.3 Not described Not described	Section 7.7 Section 7.7 Section 7.9 Section 7.11

[a] National Ambient Air Quality Standards
[b] Liters per minute
[c] Relative Humidity
[d] Standard Deviation
[e] Reference refers to the *QA Handbook for Air Pollution Measurement Systems*, Volume II. The use of "S" refers to sections within Part 1 of Volume II. The use of "MS" refers to method-specific sections in Volume II.

Measurement Quality Objectives Parameter – $PM_{2.5}$ – Continued

Requirement	Frequency	Acceptance Criteria	40 CFR Reference	QA Guidance Document 2.12 Reference
Cali bration/Verification				
FR[a] calibration	If multi-point failure	± 2% of transfer standard	Part 50, App. L, Sec 9.2	Section 6.3
FR multi-point verification	1/yr	± 2% of transfer standard	Part 50, App. L, Sec 9.2.5	Section 6.3 and 8.4
One point FR verification	1 calibration every 4 weeks	± 4% of transfer standard	Part 50, App. L, Sec 9.2	Sec 8.4
External leak check	Every 5 sampling events	80 mL/min[b]	Part 50, App. L, Sec 7.4	Section 6.6 and 8.4
Internal leak check	Every 5 sampling events	80 mL/min		Section 6.6 and 8.4
				Section 6.4
Temperature calibration	If multi-point failure	± 2% of standard	Part 50, App. L, Sec 9.3	Section 6.4 and 8.4
Temperature M-point verification	on installation, then 1/yr	± 2 °C of standard		Section 6.4 and 8.4
One-point temperature verification	1 calibration every 4 weeks	± 4 °C of standard	Part 50, App. L, Sec 9.3	Section 6.5
Pressure calibration	On installation, then 1	± 10 mm Hg[c]	Part 50, App. L, Sec 7.4	Section 8.2
Pressure verification	per year	± 10 mm Hg		Not described
Clock/timer verification		1 min/month		
Accuracy				
FRM[d] performance evaluation	25% of sites 4 per year	± 10%	Part 58, App A, Sec 3.5	Section 10.2
External leak check				
Internal leak check	4 per year	< 80 mL/min	Not described	Section 10.2
Temperature audit	4 per year	< 80 mL/min	Not described	Section 10.2
Pressure audit	4 per year	± 2 °C	Not described	Section 10.2
Balance audit	4 per year	± 10mm Hg	Not described	
	1 per year	Manufacturer's specifications	Not described	Section 10.2
				Section 10.2
Accuracy				
Flow rate audit	1 audit every 2 weeks (automated) 4 per year (manual)	± 4% of audit standard	Part 58, App A, Sec 3.5	Section 10.2
Precision				
Collocated samples	Every 6 days for 25% of sites	CV[e] ≤ 10%	Part 58, App. A, Sec 3.5 and 5.5	Section 10.2
Single analyzer	quarterly	CV ≤ 10%	Not described	Not described
Single analyzer	1 per year	CV ≤ 10%	Not described	Not described
Reporting organization	quarterly	CV ≤ 10%	Not described	Not described
Calibration and Check Standards				
Flow rate transfer standard	1 per year	± 2% of NIST[f] traceable Standard.	Part 50, App. L Sec 9.1 and 9.2	Section 6.3
Field thermometer	1 per year	± 0.10 °C resolution ± 0.5 °C accuracy	Not described	Section 4.2 and 6.4 Section 4.2 and 6.4Section 4.2 and 6.4
Field barometer	1 per year	± 1 mm Hg resolution ± 5 mm Hg accuracy	Not described	Section 4.2 and 6.4 Section 4.3 and 7.3
Working mass Standards	Once every 3-6 months	0.025 mg	Not described	Section 4.3 and 7.3
Primary mass standards	1 per year	0.025 mg	Not described	

[a] - Flow Rate
[b] - milliliters per minute
[c] - millimeters of Mercury
[d] - Federal Reference Method
[e] - Control Volume
[f] - National Institute of Science and Technology

7.2.1. General Data Quality Objectives

- All data should be traceable to a National Institute of Science and Technology (NIST) primary standard.
- All data shall be of a known and documented quality. The level of quality required for each specific monitoring project shall be established during the initial planning stages of the project and will depend upon the data's intended use. Two major measurements used to define quality are precision and bias. Refer to Section 7.2 for definitions of the metrics precision and bias.
- All data shall be comparable. This means all data shall be produced in a similar and scientific manner. The use of the standard methodologies for sampling, calibration, audition, etc. found in the QAPP should achieve this goal.
- All data shall be representative of the parameters being measured with respect to time, location, and the conditions from which the data are obtained. The use of the standard methodologies contained in the QAPP should ensure that the data generated are representative.
- Ideally, a 95% confidence of both precision and bias should be maintained with a ±15% difference or better between the actual amount of an introduced parameter (to a measurement system) and the indicated response of the measurement system.
- The QAPP must be dynamic to continue to achieve its stated goals as techniques, systems, concepts, and project goals change.

7.2.2. Specific Data Quality Objectives (NAAQS)

The purpose of ambient pollutant monitoring in Jefferson County, Alabama are to:

- determine whether or not the primary and secondary 24-hour NAAQS for particulate matter (measured as PM_{10}) of 150 micrograms per cubic meter ($\mu g/m^3$) are exceeded.
- determine whether or not the primary and secondary 24-hour NAAQS for particulate matter (measured as $PM_{2.5}$) of 35 $\mu g/m^3$ are exceeded.
- determine whether or not the primary and secondary NAAQS for particulate matter (measured as $PM_{2.5}$) of 15 $\mu g/m^3$ (annual arithmetic mean) are exceeded.
- determine whether or not the primary NAAQS for lead of 1.5 $\mu g/m^3$ (quarterly average) is exceeded.
- determine whether or not the 8-hour average NAAQS for CO of 9 parts per million (ppm) is exceeded.
- determine whether or not the hourly average NAAQS for CO of 35 ppm is exceeded.
- Determine whether or not the 8-hour average NAAQS for O_3 of 0.08 ppm is exceeded.
- determine whether or not the hourly average NAAQS for O_3 of 0.12 ppm is exceeded.
- determine whether or not the 3-hour average NAAQS for SO_2 of 0.50 ppm is exceeded.
- determine whether or not the 24-hour average NAAQS for SO_2 of 0.14 ppm is exceeded.

- determine whether or not the annual average (annual arithmetic mean) NAAQS for SO_2 of 0.03 ppm is exceeded.
- determine whether or not the annual average (annual arithmetic mean) NAAQS for nitrogen dioxide (NO_2) of 0.053 ppm is exceeded.

7.3. Network Scale

Representativeness is defined as a measure of the degree to which data accurately and precisely represent a selected characteristic of a monitored system. Support in achieving representativeness is provided through adhering to the requirements provided in:

- 40 CFR Part 58, Appendix D (Network Design for State and Local Air Monitoring Stations [SLAMS], National Air Monitoring Stations [NAMS], and Photochemical Assessment Monitoring Stations [PAMS]); and
- 40 CFR Part 58, Appendix E (Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring).

Each monitor operated is assigned a scale of representativeness based on the definitions of 40 CFR Part 58, Appendix D.

- ***Micro Scale*** - describes air volumes associated with area dimensions ranging from several meters up to about 100 meters (m).
- ***Middle Scale*** - describes air volumes associated with area dimensions up to several city blocks in size with dimensions ranging from about 100 m to 500 m (0.5 kilometer [km]).
- ***Neighborhood Scale*** - describes air volumes associated with an area of a city that has relatively uniform land use with dimensions in the 500 m to 4,000 m (0.5 to 4.0 km) range.
- ***Urban Scale*** - describes air volumes within cities with dimensions on the order of 4,000 m to 50,000 m (4.0 km to 50 km). This scale would usually require more than one site for definitions.
- ***Regional Scale*** - describes air volumes associated with rural areas of reasonably homogeneous geography that extends for tens to hundreds of kilometers.

8. TRAINING REQUIREMENTS

Adequate education and training are integral to any monitoring program that strives for reliable and comparable data. Training is aimed at increasing the effectiveness of employees and their organization. As part of a QA program, 40 CFR Part 58, Appendix A requires the development of operational procedures for training. These procedures should include information on:

- Personnel qualifications – general and position-specific
- Training requirements – by position
- Training frequency

Air monitoring personnel training consists of required reading prior to implementing the requirements of this QAPP. Documents required to be read shall include this QAPP, and the operational procedures specific to the equipment personnel will be working with or servicing. Required reading shall be documented on a "Required Reading" Form. All employees are actively encouraged to pursue training opportunities whenever posslaboratorye and as needed. Because JCDH's ambient air monitoring network is growing, new equipment, procedures, and personnel are added periodically. ARPD provides vendor based training for its personnel when new equipment is obtained. Additionally, personnel are encouraged to periodically identify, request, and attend pertinent courses and seminars. These courses and seminars may be provided as videotapes, closed circuit transmission, web based real-time interactive formats, and/or live instruction. Organizations that provide these training opportunities include local and regional universities, the Air and Waste Management Association, the Western States Air Resources Council, and EPA. Air monitoring personnel have sufficient training to currently perform necessary functions at an acceptable level.

JCDH owns and maintains a satellite dish and receiving equipment. The dish has a direct link with EPA's Air Pollution Distance Learning Network (APDLN). The APDLN offers a host of air quality related training courses. The Air Quality Monitoring Coordinator selects and schedules APDLN training sessions throughout the year and executes them according to interest and needs.

Monitoring staff provide new monitoring personnel and local station operators the necessary on the job training for their individual monitoring tasks.

9. DOCUMENTATION AND RECORDS

The following information describes JCDH's document and records procedures for the Ambient Air Quality Monitoring Program. The documents and records pertaining to all data required to be collected and all other data deemed important by under its policies and records management procedures, including documents and records required to support the concentration data reported to EPA, are listed in Table 9-1.

9.1. Information Included in the Reporting Package

9.1.1. Routine Data Activities

JCDH maintains records in appropriate files that allow for the efficient archival and retrieval of records. Ambient air quality information is included in this system. Table 9-1 includes the documents and records that are filed according to the statute of limitations discussed in Section 9.3.

9.1.2. Quarterly Data Submittal to EPA

JCDH shall submit quarterly data, as specified in 40 CFR Part 58, to EPA, either directly via AQS data entry or through the Region 4 office. This data shall be submitted no later than 90 days following the close of each calendar quarter, as specified in 40 CFR Section 58.35, and shall be certified accurate, to the best of his/her knowledge, by JCDH's Air Quality Division manager or designee. The quarterly data submittal shall contain the following summary data:

- the city name (if applicable), county name, site location street address of each monitoring station;
- the measurement scale associated with the parameter of occurrence (POC);
- the AQS site code, monitoring method code, and POC;
- the results of all valid precision, bias, and accuracy tests performed during the quarter;
- all ambient air quality data obtained on SO_2, NO_x, CO, O_3, Pb, PM_{10}, and $PM_{2.5}$; and information specified by the AQS Users Guide, *(Volume II, Air Quality Data Coding, and Volume III, Air Quality Data Storage);* and
- the location, date, pollution source, and duration of incidents of ambient level exceedances.

9.1.3. Annual Summary Reports Submitted to EPA

JCDH shall submit to the EPA an annual summary report of all the ambient air quality monitoring data from all monitoring stations designated as SLAMS, in accordance with 40 CFR Section 58.26. The report will be submitted by July 1 of each year for the data collected from January 1 through December 31 of the previous year. The report must be certified by JCDH's Air Quality Division manager, or designee, to be accurate to the best of his/her knowledge. This certification will be based on the various assessments and reports performed by the organization, in particular, the annual QA report discussed in Section 21 that documents the quality of the ambient air quality data and the effectiveness of the quality system. The report will contain the following information:

- the city name (if applicable), county name, site location street address, and measurement scale of each monitoring station;
- the AQS site code, monitoring method code, and POC;
- a list, by pollutant, of all monitoring sites in the reporting organization;
- the information specified in 40 CFR Part 58, Appendix F; and
- the location, date, pollution source, and duration of each incident of air pollution during which ambient levels of a pollutant reached or exceeded the level specified by 40 CFR Section 51.16(a) as a level which could cause significant harm to the health of persons.

9.2. Data Reporting Package Format and Documentation Control

Table 9-1 lists the documents and records that must be included in the reporting package. The details of these various documents and records will be discussed in the appropriate sections of this document. All raw data required for calculations, the submissions to the AQS database, and QA/QC data shall be collected electronically or on data forms that are included in the field and analytical methods, see Section 11. All hardcopy information shall be filled out in indelible ink. Corrections shall be made by inserting one line through the incorrect entry, initialing and dating this correction, and placing the correct entry alongside the incorrect entry, if this can be accomplished legibly, or by providing the information on a new line if the above is not posslaboratorye.

9.2.1. Logbooks

Each field and laboratory technician will be responsible for obtaining appropriate field logbooks. These logbooks will be uniquely numbered and associated with the individual and/or a specific program. The logbooks will be used to record information about the site and laboratory operations, as well as document routine operations.

Completion of data entry forms, associated with all routine environmental data operations, are required even when the field logbooks contain all appropriate and associated information required for the routine operation being performed.

- ***Field Logbooks*** - Logbooks will be used for each sampling site, specific program, or individual. Each notebook should be hardbound and paginated. Appropriate data entry forms may be used instead of logbooks; however, these forms are not required for routine operations, inspection and maintenance operations, or SOP activities as long as the information is contained in a notebook.
- ***Lab Logbooks*** – An electronic database exists in which the state laboratory retains all records pertaining to equipment calibrations and materials tracking, preparation, storage, and disposal, as well as general comments and notations and other pertinent information required for support of the Ambient Air Quality Network Data integrity activities.

9.2.2. Electronic Data Collection

Certain instruments can provide an automated means for collecting information that would otherwise be recorded on data entry forms. Information on these systems is detailed in Section 18. In order to reduce the potential for data entry errors, automated systems will be utilized where appropriate and will record the same information that would be recorded on data entry forms. In order to provide a backup, a hard copy of automated data collection information will be stored for the appropriate time frame in project files.

9.3. Data Reporting Package Archiving and Retrieval

All the information listed in Table 9-1 will be retained for three years from the date of collection in accordance with 40 CFR Section 31.42. However, if any litigation, claim, negotiation, audit, or other action involving the records has been started before the expiration of the three-year period, the records will be retained until completion of the action and resolution of all issues which arise from it, or until the end of the regular three year period, whichever is later.

Table 9-1. Reporting Package Information

Categories	Record/Document Type	File Locations
Management and Organization	State Implementation Plan Reporting Agency Information Organizational Structure Personnel Qualifications and Training Training Certification Quality Management Plan Document Control Plan EPA Directives Grant Allocations Support Contracts	
Site Information	Network Descriptions Site Files Site Maps Site Pictures	
Environmental Data Operations	Quality Assurance Project Plans Standard Operating Procedures Field and Laboratory Notebooks Sample Handling/Custody Records Inspection/Maintenance Records	
Raw Data	Any Original Data (routine and quality control) Including Data Entry Forms	
Data Reporting	Air Quality Index Reports Annual SLAMS Report Data/Summary Reports Journals/Articles/Papers/Presentations	
Data Management	Data Algorithms Data Management Plans/Flowcharts Data Management Systems Pollutant Data Meteorological Data	
Quality Assurance	Gook Laboratory Practices Network Reviews Control Charts Data Quality Assessments Quality Assurance Reports Technical System Audits Response/Corrective Action Reports Site Audits	

10. NETWORK DESCRIPTION

The purpose of this section is to:

- identify the functions associated with JCDH's Ambient Air Quality Monitoring Network.
- outline the network's objectives.
- establish the criteria for:
- sampling network design and
- monitoring site selection.
- identify the intended sampling frequency.

The primary function of the Air Monitoring Program is to verify compliance with the NAAQS. Other purposes include determining trends over time, determining effects on air quality from adjustments to source emissions, developing algorithms based on historical air quality and other conditions which will forecast air quality, verifying air quality modeling programs, providing real-time ozone data to the public, and correlating health effects to air quality.

Sampling network design and monitoring site selection comply with the following appendices of 40 CFR Part 58:

- 40 CFR Part 58, Appendix A - Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)
- 40 CFR Part 58, Appendix D - Network Design for State and Local Air Monitoring Stations (SLAMS) and National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS)
- 40 CFR Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring

10.1. Network Objectives

The Ambient Air Quality Monitoring Network is designed to meet a minimum of six basic monitoring objectives. These basic monitoring objectives are to:

- determine the highest concentrations expected to occur in the area covered by the network,
- determine representative concentrations in areas of high population density,
- determine the impact of significant sources or source categories on ambient pollution levels,
- determine general background concentration levels,
- determine the extent of regional pollutant transport among populated areas and in support of secondary standards, and
- determine the welfare-related impacts in rural and remote areas (such as visibility impairment and effects on vegetation).

utilizes the network design criteria specified in 40 CFR Part 58, Appendix D, to establish the appropriate network configuration necessary to meet these objectives.

10.1.1. Monitoring Objectives and Spatial Scales

Each monitor within JCDH's Ambient Air Quality Monitoring Network is assigned one of the following monitoring objective designations:

- ***Population exposure*** - the monitor is located in an area associated with high population density.
- ***Background*** - the monitor is located where manmade pollutant emissions are minimal.
- ***Transport*** - the monitor is located to measure pollutants transported from other areas.
- ***Maximum concentration*** - the monitor is located where a high concentration of the pollutant is expected (often based on results of receptor models).
- ***Comparison study*** - the monitor is located adjacent to other instrumentation measuring the same pollutant to compare different sampling/monitoring methodologies.
- ***Air Quality Index*** - the monitor provides data primarily for reporting to the Air Quality Index (previously called the Pollutant Standards Index).

Data collected within the network must be representative of the spatial area under study. The goal in siting a monitoring station is to match the spatial scale represented by the samples obtained with the spatial scale most appropriate for the monitoring objective of the station. For a description of representative measurement scales, see Section 7.3.

10.2. Site Selection

The selection of a specific monitoring site includes the following activities:

- developing and understanding the monitoring objective and appropriate data quality objectives,
- identifying the spatial scale most appropriate for the monitoring objective of the site,
- identifying potential locations where the monitoring site could be placed, and
- identifying the specific monitoring site.

- adheres to the site selection criteria specified in 40 CFR Part 58, Appendix E.

10.2.1. Site Location

Four criteria should be considered when evaluating potential sites. Monitoring sites should be oriented to measure the following (singly or in combination as appropriate for the sampling objective):

1. impacts of known pollutant emission categories on air quality,
2. population density relative to receptor-dose levels, both short- and long-term,
3. impacts of known pollutant emission sources (area and point) on air quality, and
4. representative air quality.

Selection according to these criteria requires detailed information concerning the location of sources, geographic variability of ambient pollutant concentrations, meteorological conditions, and population density. Selection of the number, geographic locations, and types of sampling stations is, therefore, a complex process.

The sampling site selection process also involves consideration of the following factors:

- ***Economics*** - The quantity of resources required to accomplish all data collection activities, including instrumentation, installation, maintenance, data retrieval, data analysis, QA, and data interpretation, must be established
- ***Security*** - In some cases, a preferred location may have associated problems that compromise the security of monitoring equipment (i.e., high risk of theft, vandalism, etc.). If such problems cannot be remedied through the use of standard measures such as additional lighting, fencing, etc., then an attempt to locate the site as near to the preferred location as possible shall be made.
- ***Logistics*** - This process includes procurement, maintenance, and transportation of material and personnel for the monitoring operation. The logistics process requires full knowledge of all aspects of the data collection operation: planning, reconnaissance, training, scheduling, safety, staffing, procuring goods and services, communications, and inventory management.
- ***Atmospheric Considerations*** - These considerations may include spatial and temporal variability of pollutants and their transport. Effects of buildings, terrain, and heat sources or sinks on air trajectories can produce localized anomalies of pollutant concentrations. Meteorology must be considered in determining the geographic location of a site as well as the height, direction, and extension of sampling probes. Evaluation of a local wind rose is essential to properly locate many monitoring sites (e.g., siting either to detect or avoid emissions from specific sources).
- ***Topography*** - Evaluation of the local topography based upon land use maps, U.S. Geological Survey topographic maps, and other available resources must be completed. Minor and major topological features that impact both the transport and diffusion of air pollutants must be identified and evaluated. Minor features may consist of an adjacent tree lined stream or tall structures either upwind or downwind of a point source, each of which may exert small influences on pollutant dispersion patterns. Major features include river canyons or deep valleys, mountain ranges, and large lakes. Major features significantly impact the prevailing wind patterns or create their own local weather such as katabatic or anabatic winds.
- ***Pollutant Considerations*** - The monitoring site location for a specific pollutant may or may not be appropriate for another pollutant. Evaluation of the changes that pollutants undergo temporally and spatially must be considered in order to determine the applicability of each particular site for a specific pollutant. An example would be the temporal delay in peak concentrations of NO_x and volatile organic compounds (VOCs), compared to the peak concentration of resulting O_3. A micro scale site used to monitor CO may be appropriate for measuring O_3 precursors, such as VOCs and NO_x, but entirely inappropriate for measuring O_3 itself. Due to the time delay in the creation of the secondary pollutant, O_3, a more distant neighborhood or urban scale monitoring site may be appropriate for directly monitoring O_3. An interdependence exists between all of the factors listed above. Consequently, an iterative procedure must be employed in order to successfully select appropriate sites that can provide the data necessary to accomplish the project's stated objectives. In situations where the sites do not specifically meet the requirements necessary to obtain the project objectives, reevaluation of the project

operation of air quality measurement systems; estimates of air quality, field, and theoretical studies of air diffusion; and considerations of atmospheric chemistry and air pollution effects make up the required expertise needed to select the optimum sampling site for obtaining data necessary to fulfill the monitoring objectives.

10.2.2. Monitor Placement

The placement of each monitor is generally determined by the defined monitoring objective. Monitors are thus usually placed according to potential exposure to pollution. Due to the various factors discussed above, tradeoffs are often necessary to locate a site for collection of optimally representative data. Final placement of a particular monitor at a selected site is dependent on physical obstructions and activities in the immediate area. Monitors must be placed away from obstructions such as trees and fences in order to avoid their effects on airflow. To prevent sampling bias, airflow around monitor sampling probes must be representative of the general airflow in the area. In addition, the availability of utilities (i.e., electricity and telephone services) is critical.

10.3. Probe Siting Criteria for Pollutant Sampler/Analyzer

General probe and monitoring path siting criteria for criteria pollutants shall adhere to the requirements listed in 40 CFR58, Appendix E, and the instructions outlined below.

10.3.1. Sulfur Dioxide (SO_2)

The SO_2 intake probe must be 3 to 15 m above the ground. The probe must be at least one meter away, both vertically and horizontally, from any supporting structure. The probe must be at least 2 m away from any small local obstruction, such as a pipe, pole, etc., and at least 2 m from any other sampler probe intakes. The probe should be at least 20 m from any trees or shrubs extending higher than the sampler intake. The distance shall be measured from the dripline or outside edge of the crown, not the trunk. For monitors to be operated at the same site for several years, it is best to allow some additional space for vegetation growth. Because of their ability to alter normal wind flows and provide surfaces for SO_2 deposition or absorption, trees and shrubs shall not be located between a source and the sampler. In situations where trees or shrubs could be considered an obstruction (this is particularly true of large coniferous trees), the distance between the trees or shrubs and the sampler shall be either at least 10 meters or the height the tree protrudes above the sampler intake, whichever is greater. The distance between the probe and any large obstruction (such as buildings) higher than the probe must be more than twice the height that the obstruction extends above the probe. There should be no minor sources of SO_2 (coal or oil fired stoves or furnaces) within 100 m of the probe intake that could have a significant impact.

The sampler must have an unrestricted airflow in at least a 270° arc around the sampler. The arc must include the predominant wind directions and any major sources in the area. An exception is made for probes located on the sides of buildings for measuring street canyon pollution in urban areas. In these cases, the probe must have an unrestricted airflow of 180°. See 40 CFR Part 58, Appendix E, for an explanation of these and other siting criteria.

10.3.2. Carbon Monoxide (CO)

If the site is a city street canyon and the desired measurement scale is micro scale, the probe intake must be located 3±0.5 m above the ground. Other measurement scales require the probe to be 3 to 15 m above the ground. In both cases the probe inlet must be at least one meter horizontally or vertically away from any supporting structures. The major concern with trees and shrubs is their ability to alter normal wind flow patterns. Thus, for middle and neighborhood scale stations, trees and shrubs shall not be located between the major sources of CO, usually vehicles on a heavily traveled road, and the sampler. In addition, the sampler shall be located at least 10 m from all trees. The distance must be measured from the dripline or outside edge of the crown, and not the trunk. For monitors to be located at the same site for several years, additional space must be provided when siting monitors adjacent to trees or shrubs to accommodate vegetation growth. In situations where trees or shrubs could be considered an obstruction (this is particularly true of large coniferous trees), the distance between the trees or shrubs should be either at least 20 meters or the height the tree protrudes above the sampler intake. The distance between the probe and any large obstruction (such as buildings) higher than the probe must be more than twice the height that the obstruction extends above the probe. For micro scale stations, no trees or shrubs should be located between the probe inlet and the road.

The sampler must have an unrestricted airflow in at least a 270° arc around the sampler, unless the probe is in an urban street canyon. The arc must include the predominant wind directions for the season of maximum concentration. If the probe is used in an urban street canyon and is attached to the side of a building, it must have an unrestricted airflow of 180°. For street traffic micro scale monitoring, the probe must be 2 to 10 m from the roadway and at least 10 m from an intersection. A mid-block location is preferred. For neighborhood or larger scales use the data in 40 CFR Part 58, Appendix E to calculate the required separation distance from the nearest traffic lane.

10.3.3. Ozone (O_3)

The probe intake is to be located from 3 to 15 m above the ground. The probe is to be more than 1 meter horizontally or vertically away from any supporting structures. It should be at least 20 m away from any trees or shrubs. Because of their ability to alter normal wind flow patterns and provide surfaces for absorption or reactions (the scavenging effect of vegetation is greater for ozone than for the other criteria pollutants), trees and shrubs shall not be located between a nearby source and the sampler. Samplers monitoring O_3 transported over a long distance, such as from an urban city core area, should be sited so that no trees are within 20 m of the sampler along the predominant summer daytime wind direction. The distance shall be measured from the dripline or outside edge of the crown, not the trunk. For monitors to be operated at the same site for several years, it is best to allow some additional space for vegetation growth. In situations where trees or shrubs could be considered an obstruction, the trees or shrubs must be at least 10 meters from the probe and should be at least 20 meters. The distance between the probe and any obstruction must be at least twice the height that the obstruction extends above the probe.

The sampler must have unrestricted airflow in at least a 270° arc around the sampler. The arc must include the predominant wind direction for the season of maximum concentration. 40 CFR Part 58, Appendix E gives the required separation distance from the nearest traffic lane.

10.3.4. Nitrogen Dioxide (NO_2)

The siting criteria for NO_2 analyzers is the same as for ozone analyzers.

10.3.6. Meteorological Sensors

The siting criteria for meteorological sensors vary greatly from parameter to parameter. Because of the variations, the siting criteria are discussed below on a parameter-by-parameter basis.

Instruments shall be mounted on booms at the top of, or projecting horizontally from, the tower. The booms shall be securely fastened to the tower and shall be strong enough so that they will not sway or vibrate in strong winds. Wind instruments shall be mounted on a boom so that the sensors are twice the maximum diameter or diagonal of the tower away from the tower. The boom shall project into the prevailing winds. Wind sensors shall be mounted on booms or cross arms so that a sensor's wake does not impact adjacent sensors. Usually, this means mounting the sensors a minimum of 2 meters apart. If the wind sensors are to be mounted on top of a tower, they shall be mounted at a height and distance from the tower so that the diagonal distance between the sensor and the tower is equal to twice the maximum diameter or diagonal of the tower.

Temperature sensors and solar radiation sensors that are to be mounted on a boom shall be mounted on a boom with a length that is greater than the diameter of the tower at the height at which the boom is mounted. The temperature and solar radiation sensors shall always be mounted on the south side of a tower. Temperature sensors that are mechanically aspirated shall have a downward-facing shielding.

10.3.6.1. Towers

The sensor should be securely mounted on a mast (tower or pole) that will not twist, rotate, or sway.

The towers shall be of an open grid-type construction and of sufficient strength (steel or other suitable material) to be climbed safely in order to install, service, and audit the sensors. A tower must be rigid enough to maintain all mounted instruments in proper alignment and orientation in high winds.

When instruments are located on a cross arm projecting out from the tower, the cross arms shall be securely fastened to the tower and shall be strong enough so that the sensors do not sway or vibrate in high winds. The sensors shall be securely fastened to the cross arm at a distance of two tower diameters or widths, measured from the edge of the tower to the sensor, to avoid any influence of tower-induced turbulence on the sensors. The cross arm shall be installed so that it is horizontally level and the sensors shall be installed so that they are vertical. The cross arm shall be mounted and aligned so that the wind direction sensor is correctly aligned. (The correct alignment varies on a sensor-by-sensor basis. Consult the appropriate section of manufacturer's operator's manual for the correct alignment.).

10.3.6.2. Wind Velocity Sensors

Table 10-4. Limits on Terrain and Obstacles near Towers.

Distance from Tower (m)	Slope, no Greater Than (%)	Maximum Obstruction or Vegetation Height (m)
0 – 15	± 2	0.3
15 – 30	± 3	0.5 – 1.0 (most vegetation <0.3)
30 – 100	± 7	3.0
100 – 300	± 11	10 x Ht *

If the wind sensors are to measure surface level winds, the sensors should be located on a 10-m tower in open terrain. Open terrain is defined as an area where the distance between the tower base and any obstruction is at least ten times the height of that obstruction above the instrument. This applies to manmade (buildings) and natural (trees, rocks, or hills) obstructions. All distances are to be measured from the edge of the obstruction nearest the tower. Trees and shrubs shall be measured from the outside edge of the crown or dripline, and not the trunk.

If the sensors (and tower) are to be located in areas of uneven terrain or terrain containing obstacles, refer to Table 10-4 for the limits for terrain variation and obstacle height near the tower.

10.3.6.3. Temperature and Humidity Sensors

Temperature and humidity sensors shall be mounted over an open plot of short grass or natural earth (not concrete or asphalt) at least 9 m in diameter. A height of 1.25 to 2 m above the ground surface is the standard height for mounting temperature and humidity sensors, but tower mounting, as is the case in most air pollution/meteorological monitoring applications, is also acceptable. Wherever the sensor is mounted, the height of the sensor should be measured and recorded.

The sensors shall be no nearer any obstructions than a distance of four times the height differential between the height of the sensor and the height of the obstruction. This applies to both manmade and natural obstructions.

The distance shall be measured from the edge of the crown or dripline of the vegetation, not the trunk. The sensors shall be positioned at a minimum of 30 m from large paved areas (streets, parking lots, etc.), steep slopes, ridges, hollows, or bodies of standing water. Temperature probes shall be located so that they are not influenced by heat leakage from the shelter containing the electronics and recorders for the meteorological equipment.

10.3.6.4. Barometric Pressure Sensors

Barometric pressure sensors are usually mounted inside the shelter housing meteorological instruments and recorders since barometric pressure is not affected by indoor installations. The installation of the barometric pressure sensors inside the stable shelter environment protects the instruments from exposure to extreme climatological events that may impact the sensors or recorders. However, when a sensor is mounted inside a shelter, it should be placed inside the building on an interior wall, and removed from drafts from the heating/ventilating/air conditioning

system, doors, and windows. The instrument should be mounted to minimize vibration and be vented to eliminate shelter interior pressurization.

10.3.6.5. Solar Radiation Sensors

All solar or net radiation sensors must be positioned so they are horizontal. These sensors must have an unobstructed view of the sun during the entire year, from sunrise to sunset. They should not be positioned within 50 m of any light colored walls or sources of artificial light.

If net radiation is to be measured, the sensors shall be sited according to the siting criteria for temperature sensors unless a specific application is desired.

10.3.6.6. Precipitation Sensors

A rain gauge should be positioned so that it is horizontal. The gauge's opening must be at least 3 m above the ground, but greater mounting heights are acceptable to prevent the gauge from becoming buried in snow. The gauge should be shielded from the wind, but not oriented such that excessive turbulence from the windshield would impact the collection of precipitation. In open areas, windshields such as those used by the U.S. National Weather Service should be used. The distance between obstructions, either natural or manmade, and the gauge shall be at least four times the height difference between the height of the sensor's opening and the height of the obstruction. The ground surface around the rain gauge may be either natural vegetation (grass) or gravel. Paved surfaces are not acceptable because splashing may bias the readings.

10.3.7. Acid Deposition Sensors

The siting criteria for acid deposition monitoring sites has been updated to enhance comparability of data between sites. Any acid deposition monitors installed in Jefferson County, Alabama shall be installed using the current siting criteria used by the National Atmospheric Deposition Program (NADP). For a copy of the current siting criteria, contact:

Research and Monitoring Evaluation Branch
Quality Assurance Division (MD-77B)
Atmospheric Research and Exposure Assessment
Lab Research Triangle Park, NC 27711

10.3.8. PM_{10}

When monitoring PM_{10}, it is important to select a site or sites where the collected particulate mass is representative of the monitored area.

Optimum placement of the sampling inlet for PM_{10} is at breathing height level. However, practical factors such as prevention of vandalism, security, and safety precautions must also be considered. Given these considerations, the sampler inlet for micro scale PM_{10} monitors must be between 2 and 7 m above the ground. For middle or larger spatial scales the inlet must be 2 to 15 m above the ground.

If the sampler is located on a roof or other structure, there must be 2 m separation from walls, parapets, penthouses, etc. No furnace or incineration flues should be nearby. Collocated samplers must be at least 2 m, but not greater than 4 m, away from each other.

Samplers should be located at least 20 m from the dripline of the nearest trees, but must be 10 m from the dripline when it acts as an obstruction.

The sampler must be located away from obstacles such as buildings, so that the distance between the obstacle and the sampler is at least two times the height that the obstacle protrudes above the sampler.

There must be unrestricted airflow in an arc of at least 270° around the sampler. The predominant wind direction for the season with the greatest pollutant concentration potential must be included in the 270° unrestricted arc. If the sampler is to measure concentrations from a road or point source, there must be no obstructions between a road or point source, even when other spacing from obstruction criteria are met.

There are many factors to be considered in establishing a particulate sampling location. These include accessibility under all weather conditions, availability of adequate electricity, and the security of the monitoring personnel and equipment. The sampler must be situated where the operator can reach it safely despite adverse weather conditions. If the sampler is located on a rooftop, care should be taken that the operator's personal safety is not jeopardized by a slippery roof surface. Consideration should also be given to the fact that routine operational procedures such as calibration, maintenance, and filter installation and recovery involve transporting supplies and equipment to and from the monitoring site. Refer to Appendix A, for information pertaining to High Volume PM_{10} particulate samplers.

The lack of a suitable power source can often result in the loss of many samples because of power interruptions or fluctuations. To ensure that adequate power is available consult the manufacturer's instruction manual for the sampler's minimum voltage and power requirements.

The security of the sampler depends mostly on the location. Rooftop sites with locked access and ground level sites with fences are common. In all cases, the security of the operating personnel as well as the sampler should be considered.

10.3.9. $PM_{2.5}$

When monitoring for $PM_{2.5}$, it is important to select a site or sites where the collected particulate mass is representative of the monitored area.

Optimum placement of the sampling inlet for $PM_{2.5}$ is at breathing height level. However, practical factors such as prevention of vandalism, security, and safety precautions must also be considered. Given these considerations, the sampler inlet for micro scale $PM_{2.5}$ monitors must be between 2 and 7 m above the ground. For middle or larger spatial scales the inlet must be 2 to 15 m above the ground.

If the sampler is located on a roof or other structure, there must be 2 meters separation from walls, parapets, penthouses, etc. No furnace or incineration flues should be nearby. Collocated samplers must be at least 1 m, but not greater than 4 m, away from each other.

Samplers should be located at least 20 m from the dripline of the nearest trees, but must be 10 meters from the dripline when it acts as an obstruction.

The sampler must be located away from obstacles such as buildings, so that the distance between the obstacle and the sampler is at least two times the height that the obstacle protrudes above the sampler.

There must be unrestricted airflow in an arc of at least 270° around the sampler. The predominant wind direction for the season with the greatest pollutant concentration potential must be included in the 270° unrestricted arc. If the sampler is to measure concentrations from a road or point source, there must be no obstructions between a road or point source, even when other spacing from obstruction criteria are met.

There are many factors to be considered in establishing a particulate sampling location. These include accessibility under all weather conditions, availability of adequate electricity, and the security of the monitoring personnel and equipment. The sampler must be situated where the operator can reach it safely despite adverse weather conditions. If the sampler is located on a rooftop, care should be taken that the operator's personal safety is not jeopardized by a slippery roof surface. Consideration should also be given to the fact that routine operational procedures such as calibration, maintenance, and filter installation and recovery involve transporting supplies and equipment to and from the monitoring site.

The lack of suitable power source can often result in the loss of many samples because of power interruptions or fluctuations. To ensure that adequate power is available, consult the manufacturer's instruction manual for the sampler's minimum voltage and power requirements.

The security of the sampler depends mostly on the location. Rooftop sites with locked access and ground level sites with fences are common. In all cases, the security of the operating personnel as well as the sampler should be considered.

10.4. Sampling Frequency

Minimum sampling frequencies are established by EPA and followed accordingly. The sampling frequencies of monitors are based on EPA's requirements. In instances requiring every third and sixth day sampling, specific days must be sampled in order that the entire nation is sampling on the same day. This intermittent sampling is accomplished in accordance with a national sampling schedule published annually by EPA.

The minimum number of samples required for appropriate summary statistics should be taken. At least 75% of the total posslaboratorye observations must be present before summary statistics are calculated. The exact requirements appear in Table 10-5.

10.5. Rationale for JCDH's Ambient Air Quality Monitoring Network

The emphasis of JCDH's Ambient Air Quality Monitoring Network has been in areas where elevated pollutant concentrations are known or suspected. Expanded monitoring (i.e., number of sites and increased sampling frequency) occurs in areas where a previous exceedance of a standard has been recorded.

Table 10-7. Summary of Spatial Scales for State and Local Air Monitoring Stations (SLAMS) and Required Scales for National Air Monitoring Stations (NAMS).

	Scales Applicable for SLAMS							Scales Required for NAMS						
	SO_2	CO	O_3	NO_2	Pb	PM_{10}	$PM_{2.5}$	SO_2	CO	O_3	NO_2	Pb	PM_{10}	$PM_{2.5}$
Micro	X	X			X	X	X	X	X			X	X	X[1]
Middle	X	X	X	X	X	X	X		X			X	X	X[1]
Neighborhood	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Urban	X		X	X	X	X	X			X	X			X[2]
Regional	X		X		X	X	X							X[2]

[1]Only permitted if representative of many such micro scale environments in a residential district (for middle scale, at least two).
[2]Either urban or regional scale for regional transport sites.

11. SAMPLING METHODS REQUIREMENTS

11.1. Purpose

The purpose of this section is to:

- Identify the sampling methods.
- Identify the procedures for collecting the required environmental samples.
- Describe the:
- Equipment used in the data collection network.
- Necessary support facilities.
- Sample preservation requirements.
- Implementation requirements.
- Required materials.
- Processes for preparing and decontaminating sampling equipment.
- Identify the:
- Corrective actions necessary to reestablish network data integrity.
- Responsible parties to implement the corrective actions.
- Methods required to verify corrective action effectiveness.

11.2. Monitoring Technology/Methodology

11.2.1. Carbon Monoxide (Nondispersive Infrared Photometry)

The detection and measurement of CO utilizes this chemical's propensity to absorb infrared (IR) radiation. Broadband IR radiation is generated using a high energy heated element. The IR radiation is modulated using gas filter correlation technology. Gas filter correlation utilizes a rotating wheel containing two gas filled cells that selectively modulate the IR radiation. One cell

contains nitrogen (the measure cell), while the other contains CO (the reference cell). This configuration modulates the IR radiation into reference and measure pulses.

During the reference pulse, the CO in the gas filter wheel effectively strips the beam of all IR energy at wavelengths susceptible to CO absorption. This results in a beam that is unaffected by any CO in the sample cell being evaluated.

During the measure pulse, the nitrogen in the filter wheel does not affect the IR radiation beam. The CO subsequently absorbs the IR radiation in the sample cell. The attenuation of the IR radiation is directly proportional to the quantity of CO present in the sample being evaluated.

The I R beam enters the multi-pass sample cell after the gas filter wheel. This sample cell uses folding optics to extend the absorption path through the sample, by making the reference and measure beams pass multiple times through the sample in the cell. The length of the absorption path is directly related to the sensitivity of the instrument in measuring CO concentrations.

Upon exiting the sample cell, the beam passes through a band-pass interference filter to limit the light to the wavelength of interest. Finally, the beam strikes a thermoelectrically cooled, solid-state photo-conductor. This solid-state device, coupled with its support circuitry, amplifies the signal generated by the modulated IR radiation beam, and outputs a modulated voltage. This voltage is de-modulated resulting in two voltage signals associated with the reference and measurement pulses. The ratio of the de-modulated voltage signals is indirectly proportional to the concentration of CO in the sample being evaluated.

11.2.2. Sulfur Dioxide (Fluorescence Analyzer)

The physical principle used in SO_2 molecule measurement relies on exciting an electron shell, which occurs in the presence of a specific wavelength (214 nanometers [nm]) of ultraviolet (UV) radiation, and the subsequent relaxation which produces a photon of light. A photo multiplier tube allows the light emissions to be measured as the SO_2 molecule returns to the ground state. The intensity of this light is proportional to the quantity of SO_2 present in the sample. A reference detector continuously monitors the intensity of the UV lamp, used to excite the SO_2, and allows use of a ratiometric measurement technique that compensates for lamp degradation. A hydrocarbon scrubbing system, containing no consumable material, removes interfering hydrocarbons prior to the ambient sample entering the measurement chamber.

11.2.3. Nitrogen Oxides (Chemiluminescence)

The principle of measurement is based upon the reaction of a nitrogen monoxide (NO) molecule with an internal source of O_3 in an evacuated reaction cell that results in the emission of light. Single channel instruments divide the sample into two streams. The first stream passes the sample directly to the evacuated reaction cell. A reaction between the NO present in the sample and the analyzer supplied O_3 occurs. The resulting light emitted by the reaction is monitored and correlated to the concentration of NO in the sample.

The second stream of sample gas is passed through a catalytic converter which reduces the NO_2 to NO. This second stream, now containing NO from both the reduction of NO_2 and the original NO, is cycled through the evacuated reaction cell where the new augmented concentration of NO is measured.

The measurement of the untreated sample provides an NO concentration, while the measurement of the converted sample provides a measurement of the NO_x concentration. Subtracting the NO concentration from the NO_x concentration yields the NO_2 concentration. Periodically, a background measurement is taken to correct the zero offset of the instrument to maintain zero stability.

11.2.4. Ozone (Ultraviolet Photometry)

The physical principle used to measure O_3 relies on the absorption of UV radiation by the O_3 molecule. The O_3 molecule has an affinity for specific wavelengths between 240 nm and 320 nm. The affinity peaks in the UV range at approximately 254 nm. Utilizing this phenomenon, and employing the Beer-Lambert relationship (see Equations 11-1 and 11-2), one can measure the quantity of O_3 present in a sample by determining the quantity of UV radiation absorbed along a specified path length.

To employ these concepts, a UV photometer splits the sample stream. The first stream is directed into a measurement cell, while the second stream is passed through a catalytic converter to remove all traces of O_3. The measurement cell has a specified length, a UV source at one end, and a photometer at the other end. The analyzer allows a specified time to pass, determined by the cell volume and the sample flow rate, to insure that a clean, uniform sample is present in the cell. A measurement is taken of this sample over the subsequent, equal time span. Next, the instrument cycles the catalyzed sample into the cell, utilizing the same time spans to insure a clean, O_3-free sample exists in the cell, prior to measuring the O_3-free UV attenuation level. The cycle is then repeated with a new O_3 containing sample.

11.2.5. Particulate Matter (Intermittent operation)

This methodology utilizes precisely weighed filters that are placed in a carefully controlled volumetric flow for a specified period of time. The combination of flow and duration identify a controlled volume that has passed through the clean filter. The mass added to the filter has been applied during the period when the flow was present. Determining the amount of mass added, and dividing by the volume of air filtered, yields a particulate concentration that is an average of the time the flow occurred.

These intermittent operating filter monitors require that the filters be changed between each sampling period, which usually occurs once every six days, but can be scheduled more frequently. The filters are precisely weighed in a lab prior to field installation. They are once again precisely weighed, at the same humidity level as at the initial weighing, after the filtering operation. The resulting difference yields the mass trapped during filtering.
Trapped particulate matter can be separated into finer grades of matter than was originally mandated under federal total suspended particulates (TSP) regulations using an inertial separator on the inlet stream. These inertial separators selectively pass particulate matter classified as either PM_{10} or $PM_{2.5}$.

11.2.6. Particulate Matter (Continuous Operation, TEOM)

A Tapered Element Oscillating Microbalance (TEOM) is composed of sensing and control units. At the heart of the sensing unit is the tapered element oscillating micro-balance, which is a

patented inertial mass measurement technique for making real time direct measurement of particle mass collected on a filter. This measuring equipment can determine the fine changes in mass that accumulate on the filter as a constant stream of air passes through it. The combination of the rate at which mass is accumulated on the filter and a near real-time measurement (10 minutes), coupled with the air's known volumetric flow rate, yields an accurate method of determining the concentration of particulates in the air. The equipment can calculate the 30-minute, 1-hour, 8-hour, and 24-hour averages and the total mass accumulation on the filter from the raw data. Utilizing hydrophobic filter material and collecting the sample at above ambient temperatures (50°C) minimizes humidity effects. The control unit employs an industrial microprocessor system, flow control hardware, transformers and power supplies, and a gauge to determine filter lifetime.

Initially, the air stream is filtered through an inertial separator. An inertial separator is specifically designed to eliminate particles with aerodynamic diameters either greater than 10 micrometers, or greater than 2.5 micrometers, depending upon the desired data to be collected. This equipment draws in 16.7 liters/minute (L/min) (1.0 m^3/hour) of air. After the air stream exits the inertial separator the stream is split into a 3-L/min sample that is sent to the mass transducer and a 13.7 L/min exhaust stream. The mass transducer assembly filters the sample air stream using a Teflon®-coated borosilicate glass filter. The system measures the accumulated mass every two seconds. Information required for installing and maintaining the TEOM particulate monitor is available in Appendix I, Rupprecht & Patashnick TEOM Sampler.

11.3. Sample Collection Methodology

11.3.1. Physical Collection

The physical collection of particulate filter samples, sample transport, and sample preservation techniques adhere to the requirements of 40 CFR Part 50, Appendix J, and *Quality Assurance Handbook for Air Pollution Measurement Systems,* Volume II, Ambient Air Specific Methods.

11.3.2. Electronic Data Collection

Electronic data collection is posslaboratorye through the network's data loggers and modems. This equipment is located in the shelters where the data loggers record the data history and the modems provide a path to download the data for analysis. The state's DAS is configured to automatically call the stations periodically to retrieve these data for analysis. Monitoring personnel can call the stations manually to retrieve data, or determine the status of the systems.

11.4. Support Facilities

11.4.1. Monitoring Station Design

The monitoring station design must encompass the operational needs of the equipment, provide an environment that supports sample integrity, and allow the operator to safely and easily service and maintain the equipment. Winter weather conditions must be considered during site selection in order to meet the station safety and serviceability requirements.

11.4.2. Shelter Criteria

Air pollution analyzers, with the exception of high volume samplers, dichotomous sampler heads (pump housing should be sheltered whenever practical), and meteorological sensors must be housed in a shelter capable of fulfilling the following requirements:

- The shelter temperature must be maintained between 20° and 30°C.
- The power supply should not vary more than ±10% from 117 Alternating Current Voltage (VAC). It is best to provide some type of voltage regulation to accomplish this.
- The shelter must protect the instrumentation from precipitation and excessive dust and dirt, provide third wire grounding as in modern electrical codes, meet federal Occupational Safety and Health Administration regulations, and be cleaned regularly to prevent a buildup of dust.
- The shelter must protect the instrumentation from any environmental stress such as vibration, corrosive chemicals, intense light, or radiation.

A retractable probe is used to provide sample air from the outside. Criteria pollutant analyzers require that the probe material must be either stainless steel, borosilicate glass, or an acceptable inert plastic, such as polytetrafluoroethylene (PTFE or TFE), perfluoroalkoxy (PFA), polyvinylidene fluoride (PVDF), or other Teflon®-type materials.

Other designs are possible. However, any design must ensure that the manifold's material be non-reactive with the pollutant of interest. The probe and interconnecting tubing design must provide a minimum number of bends to avoid particles impacting onto surfaces. Impacted particles may provide surfaces to which criteria pollutants may adsorb, or, if the impacted particle is metallic, catalyze to a non-criteria species. Additionally, the probe must prevent rainwater from entering the analyzers. Any liquid water will absorb pollutants, impacting the criteria pollutant concentration by removing pollutants from the sample, and consequently, yielding inaccurate environmental data.

The airflow through the probe must be sufficient to keep the residence time of gases in the probe below 20 seconds. The airflow through the probe must not be so great as to cause the pressure inside the manifold to be more than 1 inch of water below ambient. These two constraints limit the allowable configurations for the sample probe. Using the following process will verify allowable sampling provisions:

1. Construct the probe.
2. Attach a flow meter (rotameter, or positive displacement) to the probe.
3. Measure the flow rate. Adjust the flow rate so that the constraints of residence time (20 seconds maximum). If the physical configuration of the probe restricts the flow , then modify the physical configuration to rectify this deficiency. This may be accomplished by reducing the length of interconnecting tubing, increasing the tubing diameter, decreasing the number of bends in the probe, or other alterations that allow the system to meet the residence time constraints.

The probe should be replaced at least once every year or more often if dirt has built up. Dirt buildup on the inside of the probe will absorb pollutants from the air stream during high concentration periods and release pollutants during low concentration periods, skewing the data collected when the probe is dirty. The residence time of gas in glass probes and manifolds should be checked at least once every five years.

11.5. JCDH's Ambient Air Monitoring Network Samplers

The analyzers used in the JCDH Ambient Air Monitoring Network are listed in Table 11-1.

Table 11-1. JCDH's Ambient Air Monitoring Network Analyzers

Pollutant	Analyzer	EPA Reference/Equivalence
Ozone	T.E.I. 49C, T.A.P.I. 400A, T.A.P.I. 400E	REF
Carbon Monoxide	T.E.I. 48C, T.A.P.I. 300, ML 9830	REF
Nitrogen Dioxide	N/A	N/A
Sulfur Dioxide	T.E.I. 43C, ML 9850	REM
PM_{10}	Anderson 1200, BGI PQ200, R&P 1400AB	REF
$PM_{2.5}$	BGI PQ200, R&P 1400AB, Thermo 1405-DF	REF, REM

11.6. Sample Collection

All samples for criteria pollutants will be collected using Federal Reference or Equivalent Methods. Procedures set forth in the approved standard operating procedures will be used.

11.7. Sampling / Measurement System Corrective Action

Corrective action measures in the Ambient Air Quality Monitoring Network will be taken to ensure the data quality objectives are attained. There is the potential for many types of sampling and measurement system corrective actions. Each approved standard operating procedure details some expected problems and corrective actions needed for a well-run monitoring network.

11.8. Analyzer Audits

Audits are performed according to the methodology required by EPA. For each specific method and sampler type, the method followed is according to the procedures outlined in the *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II. Ambient Air Specific Methods* (EPA 199_). This handbook is commonly referred to as "The Redbook." For each

parameter and sampler type, audit procedures are performed following the procedures defined by the approved standard operating procedure.

12. SAMPLE CUSTODY PROCEDURE

Due to the potential use of data for comparison to the NAAQS and the requirement for extreme care in sample collection, sample custody procedures must be followed. The Chain of Custody (COC) Record Form will be used to track the stages of filter handling throughout the data collection operation. These forms shall be supplied to site operators when necessary. Custody procedures are detailed in the individual approved standard operating procedures.

13. ANALYTICAL METHODS REQUIREMENTS

This section will identify the equipment and analytical methods required to complete the analyses of the samples provided from the monitoring network. Where appropriate, the analytical methods will be identified by the regulatory citation, number, and date.

13.1. Purpose/Background

The analytical method employed for a specific criteria pollutant evaluation is dependant upon the monitoring technology utilized. For the gaseous criteria pollutants, SO_2, CO, NO_x, and O_3, the analyzers are designed as completely contained monitoring units that do not require additional analytical methods to establish the pollutants' environmental concentrations. The particulate matter criteria pollutants, PM_{10} and $PM_{2.5}$ do require analytical methods to evaluate the captured sample in order to establish the pollutant concentrations present in the environment.

The FRM employed by for particulate matter monitoring utilizes gravimetric analyses. JCDH's PM Laboratory will conduct these analyses. A filter's net weight gain identifies the sample characteristic of interest, captured particulate mass. This net weight gain is obtained by subtracting the initial filter weight from the final weight of the exposed filter. Once calculated, the net weight gain can be used with the total filter flow to calculate the concentration for comparison to the daily and annual NAAQS. Since the method is non-destructive, and due to posslaboratorye interest in sample composition (e.g., subsequent chemical analyses), the filters will be archived for a minimum of one year, after final gravimetric analyses have occurred.

13.2. Preparation of Samples

The PM Laboratory SOP outlining activities associated with preparing pre-sample batches will be followed. In addition to the primary and collocated sampler filters, field blanks, lab blanks, and flow check filters will also be prepared.

Upon delivery of EPA approved 46.2 mm Teflon filters, their receipt will be documented and the filters stored in the conditioning/weighing room. Each box of filters will be labeled with the date of receipt, opened one at a time, and used completely before another is opened. All filters in a lot will be used before a case containing another lot is opened. Filters will be visually inspected according to the FRM inspection criteria. Filters will then be stored in a filter conditioning room in petri-dishes. The minimum conditioning period is 24 hours. Filters will not be left out for excessive periods of conditioning since some settling of dust is possible on the top side of the filters.

13.3. Analysis Method

13.3.1. Analytical Equipment and Method

The analytical instruments employed for sample analysis of the gaseous criteria pollutants have been identified and their specific technological methods detailed in Section 11.

The analytical instrument (microbalance) that will be used for gravimetric analysis in the FRM $PM_{2.5}$ sampler method will have a readability of 1 µg and a repeatability of 1 µg. The microbalance will be setup and calibrated yearly.

13.3.2. Conditioning and Weighing Room

The primary support facility for the $PM_{2.5}$ network is the filter conditioning and weighing room at JCDH's PM Laboratory. The PM Laboratory is used to conduct pre-exposure weighing and post-exposure weighing of each $PM_{2.5}$ filter sample. The laboratory is an environmentally controlled room with temperature and humidity controls. The temperature is kept between 20 and 23 °C. The relative humidity is controlled at between 30 and 40%. The temperature and relative humidity are measured and recorded continuously during equilibration. The balance is located on a marble slab and is protected from or located out of the path of any sources of drafts. The filters are conditioned before both the pre-exposure and post-exposure weighing activities. The filters are conditioned for at least 24 hours to allow their weights to stabilize. Specific requirements for environmental control of the conditioning/weighing room are detailed in 40 CFR Part 50, Appendix L.

13.4. Internal Quality Control and Corrective Actions for Measurement Systems

A QC notebook or database (with backups) will be maintained which will contain QC data, including the microbalance calibration and maintenance information, routine internal QC checks of mass reference standards and laboratory and field filter blanks, and external QA audits. These data will duplicate data recorded on laboratory data forms but will consolidate them so long-term trends can be identified. A QC chart will be maintained on each microbalance and included in this notebook/database.

At the beginning of each weighing session the analyst will zero and calibrate the microbalance and weigh the working standards before the filters. One lab blank and one field blank will be weighed for every 10 samples weighed. A minimum of one lab and one field blank will be weighed per each weighing session. The balance will be re-zeroed between each weighing and after every tenth filter weighing, and the two working standards will be reweighed. The analyst will record the zero, working standard, and blank measurements in the laboratory data form and the laboratory QC notebook or database. If the working standard measurements differ from the certified values or the pre-exposure values by more than 3 µg, the analyst will repeat the working standard measurements. If the blank measurements differ from the pre-exposure values by more than 15 µg, the analyst will repeat the blank measurements. If the two measurements still disagree, the analyst will contact the laboratory manager, who may direct the analyst to:

1. reweigh some or all of the previously weighed filters,
2. recertify the working standard against the laboratory primary standard,
3. conduct diagnostic troubleshooting, and/or
4. arrange to have the original vendor or an independent, authorized service technician troubleshoot or repair the microbalance.

Corrective action measures in the $_{PM2.5}$ FRM system will be taken to ensure good quality data. Filter preparation and analysis checks along with corrective actions are detailed in Appendix B, $PM_{2.5}$ Rupprecht & Patashnick Partisol-FRM Model 2000 Sampler. Filter weighing will be delayed until corrective actions are satisfactorily implemented.

13.5. Filter Sample Contamination Prevention

The QA component of the $PM_{2.5}$ network has rigid requirements for preventing sample contamination. Filters are equilibrated/conditioned and stored in the same room where they are weighed. Extreme care is taken while handling filters and filters are only handled with smooth, non-serrated forceps. Upon determination of its pre-exposure weight, the filter is placed in its cassette and then placed in a protective petri dish. The petri dish is labeled with a unique ID, originating from the laboratory. Once the filter cassette is taken outside of the weigh room it will remain enclosed to minimize damage to the 46.2 mm Teflon® filter.

14. QUALITY CONTROL REQUIREMENTS

To assure the quality of data from air monitoring measurements, two distinct and important interrelated functions must be performed. One function is the control of the measurement process through broad QA activities, such as establishing policies and procedures, developing DQOs, assigning roles and responsibilities, conducting oversight and reviews, and implementing corrective actions. The other function is the control of the measurement process through the implementation of specific quality control procedures, such as audits, calibrations, checks, replicates, routine self-assessments, etc.

Quality control is the overall system of technical activities that measure the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer. In the case of the Ambient Air Quality Monitoring Network, QC activities are used to ensure that measurement uncertainty, as discussed in Section 7, is maintained within acceptance criteria for the attainment of the DQOs. Lists of pertinent QC checks are provided in the standard operating procedures and instrument manuals.

14.1. Quality Control Procedures

Quality control is achieved through periodic maintenance; flow rate audits; acceptance test procedures; accuracy, bias, and precision checks; and collocated instruments, control charts, and other verification techniques.

14.1.1. Calibrations

Calibration is the process employed to verify and rectify an instrument's measurements in order to minimize deviation from a standard. This multiphase process begins with certifying a calibration or transfer standard against an authoritative standard. The sampling or analytical instrument's measurements are then compared to this calibration/transfer standard. If significant deviations exist between the instrument's measurements and the calibration/transfer standard's measurements, corrective action is implemented to rectify the analytical instrument's measurements.

Calibration requirements for the critical field and laboratory equipment are found in the SOP's and in the specific instruments' operations manuals.

14.1.2. Precision Checks

Precision is the measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. In order to meet the DQOs for precision, will ensure the entire measurement process is within statistical control. Various tools will be employed in evaluating and monitoring precision measurements. Periodically exercising instruments with zero and span checks, employing collocated monitoring, and monitoring data integrity with control charts will provide evidence of deviations from the required precision measurement. Fifteen percent of all network sites will be outfitted with collocated monitors to actively support precision checks. Precision requirements for the applicable instrumentation are found in the SOP's and in the specific instruments' operations manuals.

14.1.3. Accuracy or Bias Checks

Accuracy is defined as the degree of agreement between an observed value and an accepted reference value. Accuracy is a combination of random error (precision), and systematic error (bias). Although collocated monitors are primarily used for evaluating and controlling precision, they can also be used to determine accuracy or bias. By employing percent difference calculations and plotting the results on control charts, trends can be observed that indicate bias occurring within the measurements. In addition to collocated monitors, daily zero and span checks can also provide data capable of identifying bias. Accuracy or bias requirements for various types of instrumentation are found in the SOP's and in the specific instruments' operations manuals.

14.1.4. Flow Rate Audits

For instruments that monitor flow, a flow rate audit will be performed every quarter. The audit is made by measuring the analyzer's normal operating flow rate using a certified flow rate transfer standard. The flow rate standard used for auditing may not be the same flow rate standard used to calibrate the analyzer. However, both the calibration standard and the audit standard may be referenced to the same primary flow rate or volume standard. Document the audit (actual) flow rate, and the corresponding flow rate measured by the sampler in the calibration worksheet associated with the equipment undergoing calibration. Details for implementing flow audits may be found in the applicable instruments' operations manuals, and in the appropriate SOP's

14.1.5. Balance Checks

Balance checks are frequent checks of the balance working standards (100 and 200 mg standards) against the laboratory balance to ensure that it is within acceptance criteria throughout weighing sessions. The laboratory will use ASTM class 1 weights for its primary and secondary (working) standards. Both working standards will be measured at the beginning and end of each weighing session. Additionally, one will be selected for a measure after every 10 filters. Balance check samples will be control charted.

14.2. Control Charts

Control charts will be used by JCDH. They provide a graphical means of determining whether various phases of the measurement process are in statistical control. The control charts will be utilized as an "early warning system" to evaluate trends in precision and bias. They will be appropriately filed and archived.

15. EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS

15.1. Purpose/Background

The purpose of this section is to discuss the procedures used to verify that all instruments and equipment are maintained in sound operating condition and are capable of operating at acceptable performance levels. All instrument inspection and maintenance activities must be documented and filed. See Section 9 for document and record details.

15.2. Testing

All gaseous criteria and particulate matter pollutant monitors used in the Ambient Air Quality Monitoring Network shall be certified to adhere to EPA equivalent or reference methods. Therefore, they are assumed to be of sufficient quality for the data collection operation. The model designations are identified in Table 15-1.

Prior to field installation, assemble and run the particulate samplers at the laboratory. The field operators will perform external and internal leak checks and temperature, pressure, and flow rate multi-point verification checks. If any of these checks are out of specification, contact the vendor for initial corrective action. Once installed at the site, the field operators will again run the tests mentioned above. If the sampling instrument meets the acceptance criteria, it will be assumed to be operating properly.

Prior to field installation of the gaseous criteria pollutant monitors, the analyzers shall successfully undergo zero/span and multi-point calibrations. Following site installation, the field operators will initiate, observe, and document the successful completion of a zero/span cycle. If the analyzers meet the acceptance criteria, they will be assumed to be operating properly. These tests will be properly documented and filed as indicated in Section 9.

15.3. Inspection

A discussion of the necessary inspections of various equipment and components is provided here. Inspections are subdivided into two sections: one pertaining to conditioning/weighing room issues and one associated with field activities.

15.3.1. Inspections in Conditioning/Weighing Room

There are several items that need routine inspection in the weigh room laboratory. Table 15-1 details the items to inspect and how to appropriately document the inspections.

15.3.2. Inspections of Field Items

There are several items that require periodically field inspection. These items are identified and procedures are presented in the applicable equipment SOPs and operations manuals.

16. INSTRUMENT CALIBRATION AND FREQUENCY

16.1. Calibration of Local Primary Standards

16.1.1. ASTM Class 1 Weights

The ASTM class 1 weights that will be used to calibrate the laboratory microbalance will be recertified annually. During the annual visit by the service technician, the in-house primary standard weights will be checked against the service technician's standards to ensure acceptability. These actions will be documented in the service technician's report, a copy of which will be provided to the laboratory manager, which after review, will be appropriately filed (see Section 9).

16.1.2. Local Primary Flow Rate Standard

The local primary flow rate standard used to calibrate the field flow rate transfer standards will be maintained and recertified against a NIST-traceable flow rate standard by the manufacturer.

16.1.3. Local Primary Temperature Standard

The local primary temperature standard used to verify the accuracy of the field temperature transfer standards will be a mercury-in-glass thermometer and will be recertified against a NIST primary standard when there is an observed shift in performance.

16.1.4. Local Primary Pressure Standard

The local primary pressure standard used to verify the accuracy of the field barometer transfer standards will be a stationary mercury barometer maintained by the LABORATORY.

16.2. Calibration of Transfer Standards

16.2.1. Flow Transfer Standards

The field flow transfer standards used for flow rate calibration will have their own certifications and will be traceable to the local primary flow rate standard. JCDH will employ the DeltaCal (the manufacturer provided streamline flow transfer standard) for field calibrations and flow rate verifications of the flow rates of the network samplers. This device has the advantage of providing volumetric flow rate values directly, without requiring conversion for mass flow measurements, temperature, pressure, or water vapor content. A calibration relationship for the flow rate standard, such as an equation, curve, or family of curves, is established by the manufacturer (and verified if needed) as accurate to within 2% over the expected range of ambient temperatures and pressures at which the flow rate standard is used. The flow rate standards shall be recalibrated and recertified at least annually.

16.2.2. Temperature Transfer Standards

The field temperature transfer standards used for calibration of temperature sensors will be the DeltaCals that have their own certification. They will be reverified/recertified at least annually against the local primary temperature standard, or auditors transfer standard, to within 2 °C over the expected range of ambient temperatures at which the temperature standard is to be used.

16.2.3. Pressure Transfer Standards

The field pressure transfer standards will be the DeltaCals that will have their own certification and will be reverified or recertified at least annually by the manufacturer.

16.3. Calibration of Laboratory/Field Equipment

The specific calibration procedures for the laboratory and field equipment can be found in the applicable SOPs or operation manuals.

16.4. Document Calibration Frequency

See the appropriate standard operating procedure for field QC checks that include frequency and acceptance criteria and references for calibration and verification tests of single and sequential sampler flow rates, temperature, pressure, and time. See the laboratory sop for a similar summary of laboratory QC checks, including the frequency of primary and working mass standards and conditioning/weigh room temperature and relative humidity.

The field sampler flow rate, temperature, and pressure sensor verification checks include one-point checks at least monthly and multipoint checks (calibration without adjustment unless needed as determined independently and then performed by the vendor's authorized service representative) at least annually, as documented by tracking on control charts.

All of these events, as well as sampler and calibration equipment maintenance, will be documented in field data records and logbooks and annotated with the flags required in Appendix L of 40 CFR Part 50 and the manufacturer's operating instruction manuals. Laboratory and field activities associated with equipment used by the technical staff will be kept in record logbooks as well. The records will normally be controlled by the laboratory and/or regional air quality managers and located in the laboratories or field sites when in use or at Regional Offices when being reviewed or used for data validation.

17. NON-DIRECT MEASUREMENTS

This section addresses data not obtained by direct measurement from the Ambient Air Quality Monitoring Program. This includes data from outside sources and historical monitoring data. At this time, JCDH has not formally determined the types of additional data that may be needed in support of the monitoring program. Possible databases and types of data and information that might be used include:

- Chemical and Physical Properties Data
- Sampler Manufacturers' Operational Literature
- Geographic Location Data
- Historical Monitoring Information
- External Monitoring Databases
- Lead and Speciated Particulate Data
- National Weather Service Data

Any use of outside data will be quality controlled to the extent possible following QA procedures outlined in this document and in applicable EPA guidance documents.

18. DATA MANAGEMENT

18.1. Purpose/Background

The following section will identify the processes and procedures that are to be followed to acquire, transmit, transform, reduce, analyze, store, and retrieve data. These processes and procedures will maintain the data integrity and validity through application of the identified data custody protocols.

18.2. Data Recording

The majority of the data collected in JCDH's network is recorded electronically. To accomplish this, each monitoring site is equipped with data loggers. A data logger is set up to record each monitor's output, perform specific data manipulations, and format the resulting data in preparation for downloading to a database or spreadsheet.

Data that require manual entry, such as those obtained from high volume samplers, are recorded onto the appropriate data sheet (Figure 18-1). JCDH personnel insert the sampling filter weights obtained from the laboratory and sampler runtime data into spreadsheets. These spreadsheets have been augmented with macros specifically designed to support these efforts, increasing efficiency and minimizing errors. The exposed filters are returned to the PM Laboratory for post-sampling analysis according to protocols. The final results are posted on the file transfer protocol (FTP) site, where the data is extracted and recorded onto a database to complete the manual data recording effort.

18.3. Data Validation

Each of the network's analytical instruments employed to measure meteorological conditions and the ambient concentrations of the criteria pollutants undergoes periodic audits and calibrations. These procedures are outlined in the appropriate SOPs. Performance audits and calibrations ascertain the accuracy, precision, and repeatability of each instrument in performing its required function.

The data generated by the instruments are stored on site in the data logger. When the data are accessed through the phone lines, they are downloaded to a database where they will undergo verification, reduction, and analysis.

Data verification is performed electronically by searching the data for status flags and comparing reported values to criteria that identify whether the data are within acceptable range criteria. Once data have been flagged as questionable, air quality analysts evaluate the associated data to identify underlying causes and make the decision whether the data are valid. If the data are invalid, they are not used in calculations. If the data are valid, but flagged due to some extenuating circumstance, then the data will be used in calculations, accompanied by a comment documenting the situation.

18.4. Data Transformation

The inherent accuracy of an instrument is incorporated into the system accuracy when the instrument is calibrated. Each criteria pollutant-monitoring instrument has its own internal potentiometers, whether digital or analog, adjusted to accurately reflect the concentration at which the instrument is tested. Each instrument is assumed to be linear within the range of 10% to 90% of full scale. As long as the background concentrations do not violate this range, the accuracy of the instrument is not questioned.

The network's CO analyzers are equipped with zero and span concentration potentiometers that are adjusted during the calibration operation to coordinate the magnitude of the electronic output to match the actual gas concentrations present in the analysis cell. Additional information is available in the CO SOP and the individual analyzer's operations manuals.

The network's NO_x analyzer is equipped with digital zero and span concentration potentiometers that are automatically adjusted during the calibration operation. The onboard central processing unit (CPU) alters the potentiometers' settings to coordinate the magnitude of the electronic output to match the actual gas concentrations present in the analysis cell. Additional information is available in the NO_x SOP and the individual analyzer's operations manuals.

The network's SO_2 analyzers are equipped with front panel span potentiometers that can be operator adjusted during the calibration operation. Additionally, the high voltage to the Photomultiplier Tube (PMT) or the gain on the final amplifier can be adjusted to make the analyzer agree with known SO_2 concentrations. Signals resulting from scattered UV light inside the sample cell, background radiation detected by the PMT when no SO_2 is present, are suppressed using the zero potentiometer. Additional information is available in the SO_2 SOP and the individual analyzer's operations manuals.

The network's O_3 analyzer is equipped with internal subroutines that adjust the zero and span internal calibration variables during the actual calibration operation. Basically, the CPU adjusts

the internal digital zero and span potentiometer to coordinate the analyzer's voltage output and the indicated calibration gas value. Additional information is available in the O_3 SOP and the individual analyzer's operations manuals.

JCDH utilizes a photometric ozone calibrator for generating the necessary O_3 gas concentrations required to calibrate the O_3 analyzers. A description of how the O_3 calibrator functions and step by step procedures can be found in the appropriate standard operating procedure and instrument operations manual.

Meteorological instrument calibration information is available in the Meteorological SOP and the individual instruments' operations manuals.

Mass flow controller calibration information is available in the instrument's operations manual.

18.5. Data Transmittal

Data transmittal is accomplished using telephone line access to the site's modem, which is linked to the data logger. Downloading of collected data does not delete the data from the data logger. Data are removed from the data logger continuously by overwriting data on a first-in, first-out basis. This configuration requires that the data be extracted from the data logger on a regular basis, thus preventing any loss of data. If communications problems arise, the data will have to be retrieved either by going to the site and directly accessing the data logger, or retrieving the data remotely once the communications problems have been rectified. A site visit is mandatory if the communications problems are not expected to be corrected in time to prevent data from being overwritten.

Strip chart recorders (electronic or manual) are used to simultaneously record the analog output of the particular criteria pollutant monitor. This secondary data-recording device is used to augment the data integrity and to verify suspect data points in the digital database.

Data transmittal required for manually determined values associated with the remote measurement of particulate filter's mass increases are accomplished via the MTL software. Once the used filters are returned to the laboratory, they are processed and evaluated. The resulting data is then loaded into the MTL software from which JCDH downloads the values.

All transmitted raw data sets are stored electronically. These data sets are retained intact by archiving the raw data. Data reduction operations can be performed repeatedly without violating the integrity of the original raw data set.

18.6. Data Reduction

Data reduction activities aggregate raw data into averages that are required to compare against the NAAQS criteria pollutant limits. These values obtained from reducing these data sets establish whether or not the NAAQS have been exceeded.

Regional air quality operators provide the raw data sets from the instruments. These data sets are either electronically transferred from the data recorders, or they are created manually using data validation worksheets. In either case, flags indicating the validity of the data are provided with each data point.

Air quality monitoring analysts review the data sets for invalid data flags. If the data are deemed invalid, they are disqualified from the data set, and consequently, not used in the calculation. Criteria for the quantity of valid data points required within a data set is defined in 40 CFR Part 50. These criteria are adhered to when performing the data reduction operations.

Retaining copies of all data sets electronically recorded provides a data audit trail. These data sets are archived on backup systems in addition to being retained on computers.

18.7. Data Analysis

The network-provided raw data sets are reduced, yielding the appropriate averaging period values. These results are compared to the NAAQS for the specific criteria pollutants under consideration. Acceptable values are those that do no exceed the established NAAQS values.

18.8. Data Storage and Retrieval

The storage and retrieval of the air quality monitoring data shall be possible through JCDH's archiving system. The data shall be stored for a period of three years, unless any litigation, claim, negotiation, audit, or other action involving the records has been started before the expiration of the three-year period. If this happens, the records will be retained until completion of the action and resolution of all issues that arise from it, or until the end of the regular three-year period, whichever is later.

The data shall be stored on electronic media (such as Write-Once, Read-Many [WORM] CDs or magnetic tapes) or in hard copy, whichever proves most advantageous. After the storage period has passed, the storage media may be disposed of or recycled.

19. ASSESSMENTS AND RESPONSE ACTIONS

An assessment is the process used to measure the performance or effectiveness of the quality system, the Ambient Air Quality Monitoring Network and its sites, and various measurement phases of the data operation. In order to ensure the adequate performance of the quality system, either JCDH, ADEM, and/or EPA will perform

Management Systems Reviews

Network Reviews

Technical Systems Audits

Data Quality Audits

Data Quality Assessments
Assessment Activities and Project Planning

19.1. Management Systems Review

A Management Systems Review (MSR) is a qualitative assessment of a data collection operation or organization. A MSR is employed to establish whether the prevailing quality

management structure, policies, practices, and procedures are adequate to ensure data obtained are of the necessary type and quality to support the decision process.

A MSR of the Ambient Air Quality Monitoring Program will be conducted every three years by EPA Region 4 quality assurance staff. The MSR will use appropriate federal regulations and this QAPP to determine the adequate operation of the ambient air monitoring program and its related quality system. The EPA will report its findings to senior management. The report will be filed appropriately. The EHPS/QAC or a duly appointed representative will regularly monitor progress on corrective action(s).

19.2. Network Reviews/Assessments

Conformance with network requirements of the Ambient Air Quality Monitoring Network as set forth in 40 CFR Part 58, Appendices D and E are determined through annual network reviews of the ambient air quality monitoring system, as required by 40 CFR Section 58.20(d). The network review is used to determine if a particular air monitoring network is collecting adequate, representative, and useful data in pursuit of its air monitoring objectives. Additionally, the network review may identify possible network modifications to enhance the system or correct deficiencies in attaining network objectives.

Prior to implementing a network review, significant data and information pertaining to the network will be compiled and evaluated. Such information might include:

- network files (including updated site information and site photographs);
- AQS reports;
- network monitors' five year air quality summaries;
- major metropolitan area emissions trends reports;
- emissions information, such as a monitor's emission density maps and maps delineating an area's major emissions sources; and
- National Weather Service summaries for the monitoring network area.

Upon receiving the information it will be checked to ensure it is current. Discrepancies will be noted and resolved during the review. Files and/or photographs that need to be updated will also be identified during the review. The following categories will be emphasized during network reviews:

State and Local Air Monitoring Stations. Adequacy of the network will be determined using the following information:

- maps of historical monitoring data,
- maps of emission densities,
- dispersion modeling,
- special studies/saturation sampling,
- best professional judgment,

- State Implementation Plan requirements, and
- revised monitoring strategies (e.g., lead strategy, reengineering air monitoring network).

National Air Monitoring Stations. Areas to be monitored must be selected based on the urban population and pollutant concentration levels. To determine whether the number of NAMS are adequate, the number of NAMS operating will be compared to the number of NAMS specified in 40 CFR Part 58 Appendix D.

Monitor Locations. For SLAMS, the geographical location of monitors is not specified in the regulations, but is determined by on a case-by-case basis to meet the monitoring objectives specified in 40 CFR Part 58, Appendix D. Suitable monitor locations can only be determined on the basis of stated objectives. Maps, graphical overlays, and GIS-based information will be helpful in visualizing or assessing the adequacy of monitor locations. Plots of potential emissions, historical monitoring data, and/or saturation study findings versus monitor locations will also be used.

During the network review, the stated objective for each monitoring site will be reconfirmed and the location's spatial scale will be re-verified. If the site location does not support the stated objectives, or the designated spatial scale, changes will be proposed to rectify the discrepancy.

Probe Siting Requirements. Applicable siting criteria for SLAMS and NAMS are specified in 40 CFR Part 58, Appendix E. The on-site visit will consist of physical measurements and observations to determine compliance with the 40 CFR Part 58, Appendix E requirements, such as height above ground level, distance from trees, appropriate ground cover, etc. Since many of 40 CFR Part 58 Appendix E requirements will not change within one year, this check at each site will be performed every three years.

- the most recent hard copy of site description (including any photographs);
- seasonal, pollutant-specific data identifying the greatest potential for high concentrations; and
- data describing predominant seasonal wind directions.

A checklist similar to the checklist used by the EPA regional offices during their scheduled network reviews will be used. This checklist can be found in the SLAMS/NAMS/PAMS Network Review Guidance, which is intended to assist the reviewers in determining conformance with 40 CFR Part 58, Appendix E. In addition to the items on the checklist, the reviewer will also perform the following tasks:

- ensure that the inlet is clean;
- check equipment for missing parts, frayed cords, damage, etc;
- record findings in field notebook and/or checklist;
- take photographs/videotape in the eight directions (E, SE, S, SW, W, NW, N, and NE); and
- document site conditions with additional photographs/videotape.

In addition to the items included in the checklists, other subjects for discussion as part of the network review and overall adequacy of the monitoring program will include:

- installation of new monitors,
- relocation of existing monitors,
- siting criteria problems and suggested solutions,
- problems with data submittals and data completeness,
- maintenance and replacement of existing monitors and related equipment,
- quality assurance problems,
- air quality studies and special monitoring programs, and
- other issues such as proposed regulations and funding.

The network review will be documented in a report within two months of completion. This report will be distributed to the appropriate senior staff, and EPA.

19.2.1. Particulate Matter Network Reviews

A particulate matter (PM_{10} and $PM_{2.5}$) network review will be completed every year. Since the EPA regions are also required to perform these reviews, JCDH and ADEM will coordinate their activity with EPA Region 4 in order to perform the activity at the same time (if possible). The following criteria will be considered during the review:

- date of last review;
- areas where attainment/non-attainment re-designations are likely to take place, or did take place;
- results of special studies, saturation sampling, point source oriented ambient monitoring, etc; and
- proposed network modifications since the last network review.

The number of particulate matter monitors required, depending upon the measurement objectives, is discussed in 40 CFR Part 58. Additional details exist in the *Guidance for Network Design and Optimum Exposure for $PM_{2.5}$ and PM10.*

19.2.2. Technical Systems Audits

A technical systems audit (TSA) is a thorough and systematic on-site qualitative audit, where facilities, equipment, personnel, training procedures, protocols, and record keeping are examined for conformance with the QAPP. A TSA will be performed during the early stage of the project to assist in identifying deficiencies and providing timely corrective actions.

A TSA team or an individual TSA auditor may segregate TSA activities into three categories. The categories may be audited independently or they may be combined. The TSA categories are:

- Field activities - Handling, sampling, and shipping.

- Laboratory activities - Pre-sampling weighing, shipping, receiving, post-sampling weighing, archiving, and associated QA/QC activities.
- Data management activities – Collecting, flagging, editing, and uploading data; providing data security.

Key personnel to be interviewed during the audit are those individuals with responsibilities for planning, field operations, laboratory operations, QA/QC, data management, and reporting.

The audit team will prepare a brief written summary of findings, organized into the following areas:

- planning,
- field operations,
- laboratory operations,
- QA/QC,
- data management, and
- reporting.

Problems with specific areas will be ranked and researched, and corrective actions will be implemented.

19.2.3. Post-Audit Activities

The major post-audit activity is the preparation of the systems audit report. The report will include:

- audit title, identification number, date of report, and any other identifying information;
- audit team leaders, audit team participants, and audited participants;
- background information about the project, purpose of the audit, dates of the audit, particular measurement phase or parameters that were audited, and a brief description of the audit process;
- summary and conclusions of the audit and corrective action required; and
- attachments or appendices that include all audit evaluations and audit finding forms.

To prepare the report, the audit team will meet and compare observations with collected documents and results of interviews with key personnel. Expected QAPP implementation is compared with observed accomplishments and deficiencies. The audit findings are reviewed in detail, and, within 30 calendar days of the completion of the audit, a comprehensive audit report will be generated and distributed to senior staff for comment.

If the affected parties have written comments or questions concerning the audit report, the audit team will review and incorporate them as appropriate. Subsequently, a modified report will be

prepared and resubmitted in final form within 30 days of receipt of the written comments. The report will include an agreed-upon schedule for corrective action implementation.

19.2.4. Follow-up and Corrective Action Requirements

As part of corrective action and follow-up, an audit finding response form will be generated by the audited organization for each finding in the TSA report. The audit finding response form is signed by the Regional air quality managers and sent to the TSA team, which reviews, and accepts or rejects the corrective action. The audit response form will be completed within 30 days of acceptance of the audit report.

19.2.5. Performance Evaluation

Performance evaluation activities are addressed by JCDH and its contractors' participating in the EPA's National Performance Audit Program (NPAP). Only qualified and authorized personnel execute performance audits.

19.2.6. Audit of Data Quality

An audit of data quality (ADQ) reveals how data are handled, what judgments were made, and whether uncorrected mistakes were made. An ADQ can often identify the means to correct systematic data reduction errors. An ADQ shall be performed every year. Sufficient time and effort will be devoted to this activity so that the auditors have a clear understanding and complete documentation of data flow. Pertinent ADQ questions appear on the TSA check sheets, which shall be used in executing an ADQ. The TSA check sheets shall be used to ensure that the data collection and handling integrity is maintained. The ADQ will serve as an effective framework for organizing the extensive amount of information gathered during the audit of laboratory, field monitoring, and support functions within the agency. The ADQ will have the same reporting/corrective action requirements as the TSA.

19.2.7. Data Quality Assessments

A data quality assessment (DQA) is the statistical analysis of environmental data to determine whether the data meet the assumptions that the DQOs and data collection design were developed under and whether the total error in the data is tolerable. Calculations for DQA activities shall follow the requirements and equations identified in 40 CFR Part 58, Appendix A, Section 5, and reiterated in Section 14 of this QAPP. The DQA process is described in detail in the *Guidance for the Data Quality Assessment Process,* EPA QA/G-9.

Measurement uncertainty will be estimated for both automated and manual data recording methods. Terminology associated with measurement uncertainty is found within 40 CFR Part 58, Appendix A.

Estimates of the data quality will be calculated on the basis of single monitors and aggregated to all monitors. The individual results of these tests for each method or analyzer shall be reported to EPA. Data quality assessment findings will be included in JCDH's QA annual report.

19.3. Assessment Documentation

19.3.1. Number, Frequency, and Types of Assessments

Audits shall be executed during the course of this project at the frequency and quantity indicated. Network Reviews shall be conducted every year that the Ambient Air Quality Monitoring Network is operational. Management systems reviews shall be conducted once during every three-year period that the Ambient Air Quality Monitoring Network collects data verifying compliance with the NAAQS. TSAs shall be performed once during every three-year period that the Ambient Air Quality Monitoring Network collects data verifying compliance with the NAAQS. Application of additional TSAs shall be at the discretion of the ARPD's Quality Director. Performance evaluation audits shall be performed in accordance with the schedule established by EPA's NPAP. An ADQ shall be performed every year that the Ambient Air Quality Monitoring Network is operational.

19.3.2. Assessment Personnel

The following sections identify the responsibilities of individuals within the monitoring organization. These individuals are responsible for executing audits, assessing findings, developing and implementing necessary corrective actions, preparing QA reports, evaluating their impact, and implementing follow-up actions.

19.3.2.1. Environmental Health Program Manager/ Quality Assurance Manager (EHPM/QAM)

EHPM/QAM maintains overall responsibility for management and administrative aspects of the QA program.

19.3.2.2. Air Monitoring Manager (AMM)

The AMM is responsible for assessing audit findings, issuing appropriate response/corrective actions, assigning response/corrective actions to specific personnel, and assuring the completeness and efficacy of the work. The AMM is also responsible for assuring that the Environmental Health Program Supervisor/ Quality Assurance Coordinator (EHPS/QAC) maintains the documentation as defined in the network design (40 CFR Part 58, Appendix D) and for disseminating information appearing in audit reports and other quality-related documents to field and laboratory operations personnel.

19.3.2.3. Environmental Health Program Supervisor/ Quality Assuarance Coordinator(EHPS/QAC)

The EHPS/QAC is responsible for coordinating the information management activities for SLAMS/NAMS data entry. Specific activities related to audit execution include ensuring access to data for DQA and ADQ activities.

19.3.2.4. Environmental Health Specialists (EHS)

The Environmental Health Specialists (EHS) is responsible for implementing day-to-day QA activities for the Ambient Air Quality Monitoring Program, assisting with data quality assessments and other internal audits, and calculating precision and bias data generated by the collocated $_{PM2.5}$ monitors. They are also responsible for documenting the response to required corrective actions in response/corrective action reports (see section 20.1.5).

19.3.2.5. PM Laboratory Analyst

The PM Laboratory Analyst is responsible for identifying problems, overseeing the corrective action, and assuring that the appropriate documentation is generated, distributed and filed. The PM Laboratory Analyst is also responsible for reviewing laboratory QC data such as control charts, assuring that repairs and preventive maintenance are completed and that the maintenance is effective, and assuring that interns under their supervision maintain their documentation files as defined in the relevant SOPs. The PM Laboratory Analyst will assist the EHPS/QAC in preparing QA reports and summaries.

19.3.3. Reporting and Resolution of Issues

In order to address the findings from audits, peer reviews and other assessments, the following structure and associated protocols shall be employed to identify and implement corrective actions.

Any participant in the collection, analysis, audit/assessment, and report generating activities affiliated with the Ambient Air Quality Monitoring Network is responsible for identifying the need for corrective actions. Identifying the need for corrective actions can occur during site visits, audits, data analysis operations, or other monitoring network activities. This shared responsibility, coupled with diligent attention to detail and accuracy, will assure that the Ambient Air Quality Monitoring Network consistently collects quality data, and that this data is reduced, analyzed, and presented in an accurate and representative manner. Any participant that perceives a need for corrective action(s) shall present the situation to their supervisor and the AMM within 30 days of perceiving the need.

The AMM will assess the need for a corrective action. If one is deemed necessary, a suitable corrective action will be selected and disseminated to the EHPS/QAM and the originator within 30 days.

The EHPS/QAC is responsible for implementing corrective actions. An implementation notice will be supplied to the AMM upon completion of the corrective action. The corrective action must be implemented within 30 days notwithstanding extenuating circumstances.

Following implementation of a corrective action, the AMM may, at their discretion, require a TSA to verify the efficacy of the corrective action. Both the action of implementing the corrective action and the influence of the corrective action on the operations of the Ambient Air Quality Monitoring Network must be appraised. Any deficiencies in the correction must be noted and the procedure updated to completely correct the discrepancy.

20. REPORTS TO MANAGEMENT

This section describes the quality-related reports and communications to management necessary to support SLAMS/NAMS network operations and the associated data acquisition, validation, assessment, and reporting. Unless otherwise indicated, all reports will contain monitoring data for criteria pollutants, including $PM_{2.5}$.

20.1. Frequency, Content, and Distribution of Reports

Reports to management required for the SLAMS program in general are discussed in various sections of 40 CFR Parts 50, 53, and 58. Guidance for management report format and content is provided in reports developed by EPA's Quality Assurance Division and Office of Air Quality Planning and Standards. These reports are described in the following subsections.

20.2. Quality Assurance Annual Report

Periodic assessments of SLAMS data quality are required to be reported to EPA (40 CFR Part 58, Appendix A, Section 1.4). JCDH's QA annual report is issued to meet this requirement. This document describes the quality objectives for measurement data and how those objectives have been met. The QA annual report also reviews the SLAMS air quality surveillance system on an annual basis to determine if the system meets the monitoring objectives defined in 40 CFR Part 58, Appendix D. Such review identifies needed modifications to the network such as termination or relocation of unnecessary stations or establishment of new stations.

20.3. Network Reviews

The ARPD prepares network reviews in accordance with requirements in 40 CFR Section 58.20(d). The purpose of the network reviews is to determine if a system meets the monitoring objectives defined in 40 CFR Part 58, Appendix D. The review identifies needed modifications to the network including termination or relocation of unnecessary stations or establishment of new stations.

As required by 40 CFR Part 58, Appendix A, Section 4(a), revised July 18, 1997, has provided a list of all monitoring sites and their AQS site identification codes to EPA Region 4 and to AQS. Whenever there is a change in this list of monitoring sites or in a reporting organization, reports this change to EPA Region 4 and to AQS.

20.4. Quarterly Reports

Each quarter, JCDH will report to AQS the results of all precision, bias, and accuracy tests it has carried out during the previous quarter. The quarterly reports will be submitted consistent with the data reporting requirements specified for air quality data as set forth in 40 CFR Part 58, Appendix A, Section 4. The data reporting requirements of 40 CFR Section 58.35 apply to those stations designated SLAMS or NAMS. Required accuracy and precision data are to be reported on the same schedule as quarterly monitoring data submittals.

In accord with the Federal Register Notice of July 18, 1997, all QA/QC data collected will be reported and will be flagged appropriately. This data includes: "results from invalid tests, from tests carried out during a time period for which ambient data immediately prior or subsequent to the tests were invalidated for appropriate reasons, and from tests of methods or analyzers not approved for use in SLAMS monitoring networks . . ." (40 CFR Part 58, Appendix A, Section 4; revised July 18, 1997).

Air quality data submitted for each reporting period will be edited, validated, and entered into the AQS using the procedures described in the *AQS Users Guide, Volume II, Air Quality Data Coding.* JCDH will be responsible for preparing the data reports, which will be reviewed by the EHPS/QAC before they are transmitted to EPA.

20.5. Technical System Audit Reports

EPA Region IV performs technical system audits of the monitoring system. These reports are issued by the Air Quality Division Office and are reviewed by the AMM. These reports will be filed and made available to EPA personnel during their technical systems audits. External systems audits are conducted at least every three years by EPA Region 4 as required by 40 CFR Part 58, Appendix A, Section 2.5.

20.6. Response/Corrective Action Reports

The response/corrective action report procedure will be followed whenever a problem is found such as a safety defect, an operational problem, or a failure to comply with procedures. A separate report will be required for each problem identified. The response/corrective action report is one of the most important ongoing reports to management because it documents primary QA activities and provides valuable records of QA activities that can be used in preparing other summary reports. Copies of response/corrective action reports will be distributed twice: first when the problem has been identified and the action has been scheduled, and second when the correction has been completed. The response/corrective action reports will be generated by an assigned EHS or the EHPS/QAC. The report will be distributed to the AMM and the EHPS/QAC.

20.7. Control Charts with Summary

Control charts for laboratory instruments are updated after every new calibration or standardization, as defined in the relevant SOP. EHSs are responsible for reviewing each control chart immediately after it is updated and for taking corrective actions whenever an out-of-control condition is observed. Control charts are to be reviewed at least quarterly by the EHPS/QAC.

21. DATA VALIDATION AND USABILITY

The purpose of this element is to state the criteria for deciding the degree to which each data item has met its quality specifications. Investigators should estimate the potential effect that each deviation from the QAPP may have on the usability of the associated data item, its contribution to the quality of the reduced and analyzed data, and its effect on decisions.

21.1. Sampling Design

Sampling network design and monitoring site selection must comply with:

- 40 CFR Part 58, Appendix A - Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)
- 40 CFR Part 58, Appendix D - Network Design for State and Local Air Monitoring Stations (SLAMS) and National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS)
- 40 CFR Part 58, Appendix E - Probe and Monitoring Path Siting Criteria for Ambient Air Quality Monitoring.

Additional guidance is provided in *Guidance for Choosing a Sampling Design for Environmental Data Collection,* (EPA QA/G-5S).

Any deviations from the minimum siting criteria (e.g., shelter location, probe placement, and/or monitor sight path requirements) shall be thoroughly documented in the site's QC documentation. Examples of deviations include, but are not limited to, insufficient distance from roadways (i.e., marginal terrain criteria) and insufficient distance from influencing objects (e.g., dripline of an adjacent tree or a cell phone tower that was installed after the monitoring site was established). The impact of the deviations should be evaluated and appropriate adjustments to the confidence intervals should be determined.

21.1.1. Sample Collection Procedures

Sample collection procedures are outlined in Section 11 of this QAPP. Potentially unacceptable data points are routinely identified in the database through electronic application of error flags. Each instrument-specific flag is associated with an unique error. These error flags are routinely reviewed as part of the data validation process. This activity assists in identifying suspect (potentially bad) data points that could invalidate the resulting averaging periods. A compilation of the error flags in presented in Table 21-1.

Any deviation from the established sample collection plan must be documented in the appropriate logbook and on the field sample data sheet. Accurate and complete documentation of any sample collection deviations will assist in any subsequent investigations or evaluations. Investigations and evaluations may be necessary to determine whether the data obtained from a particular site may qualify as a baseline or indicator for other sites.

Table 21-1. Qualifier Code Description and Type.

Flag	Flag Description	Flag Qualifier Type	Purpose
A	High Winds	EX	Applied only after application process completed and accepted by AQS.
B	Stratospheric Ozone Intrusion	EX	
C	Volcanic Eruptions	EX	
D	Sandblasting	EX	

E	Forest Fire	EX	
F	Structural Fire	EX	
G	High Pollen Count	EX	
H	Chemical Spills and Industrial Accidents	EX	
I	Unusual Traffic Congestion	EX	
J	Construction/Demolition	EX	
K	Agricultural Tilling	EX	
L	Highway Construction	EX	
M	Rerouting of Traffic	EX	
N	Sanding/Salting of Streets	EX	
O	Infrequent Large Gatherings	EX	
P	Roofing Operations	EX	
Q	Prescribed Burning	EX	
R	Clean Up After a Major Disaster	EX	
S	Seismic Activity	EX	
U	Sahara Dust	EX	

AA	Sample Pressure Out of Limits	NULL	Void the data and submit the code in its place.
AB	Technician Unavailable	NULL	
AC	Construction/Repairs in Area	NULL	
AD	Shelter Storm Damage	NULL	
AE	Shelter Temperature Outside of Limits	NULL	
AF	Scheduled But Not Collected	NULL	
AG	Sample Time Out of Limits	NULL	
AH	Sample Flowrate Out of Limits	NULL	
AI	Insufficient Data (Cannot Calculate)	NULL	
AJ	Filter Damage	NULL	
AK	Filter Leak	NULL	
AL	Voided by Operator	NULL	
AM	Miscellaneous Void	NULL	
AN	Machine Malfunction	NULL	
AO	Bad Weather	NULL	
AP	Vandalism	NULL	
AQ	Collection Error	NULL	
AR	Lab Error	NULL	
AS	Poor Quality Assurance Results	NULL	
AT	Calibration	NULL	
AU	Monitoring Waived	NULL	
AV	Power Failure	NULL	
AW	Wildfire Damage	NULL	
AX	Precision Check	NULL	
AY	QC Control Points (Zero/Span)	NULL	
AZ	QC Audit	NULL	

Flag	Flag Description	Flag Qualifier Type	Purpose
BA	Maintenance/Routine Repairs	NULL	
BB	Unable to Reach Site	NULL	
BC	Multi-Point Calibration	NULL	
BD	Automatic Calibration	NULL	
BE	Building/Site Repair	NULL	
BF	Precision/Zero/Span	NULL	
BG	Missing Ozone Data Not Likely to Exceed Level of Standard	NULL	
BH	Interference/Co-Elution	NULL	
BI	Lost or Damaged In Transit	NULL	
BJ	Operator Error	NULL	
1	Deviation From a CFR/Critical Criteria Requirement	QA	Data Integrity
2	Operational Deviation	QA	
3	Field Issue	QA	
4	Lab Issue	QA	
5	Outlier	QA	
6	QAPP Issue	QA	
7	Below Lowest Calibration Level	QA	
8	QA/QC Unknown	QA	
V	Validated Value	QA	
W	Flow Rate Average Out of Specification	QA	
X	Filter Temperature Difference Out of Specification	QA	
Y	Elapsed Sample Time Out of Specification	QA	

EX = Exceptional or unusual natural occurance

NULL = invalid data.

QA = data does not meet all acceptance criteria but is not believed to be invalid.

21.1.2. Sample Handling

Record pertinent deviations from established sample-handling protocols for each sample physically retrieved for monitoring sites and equipment. These deviations shall be recorded on the sample custody sheet assigned to each filter for particulate matter and recorded in the applicable electronic database for all other criteria pollutants.

21.1.3. Analytical Procedures

The data obtained from the electronic evaluation of criteria pollutant concentrations shall be validated and verified utilizing both manual and electronic methods. Specific criteria are employed that identify the range of acceptable data, the minimum and maximum acceptable values, the rate of change of specific values, and other criteria that are indicative of valid qualifying data. Suspect data are flagged utilizing the list provided in Table 21-1.

21.1.4. Quality Control

Section 14 specifies the QC checks that are to be performed during sample collection, handling, and analysis. These include analyses of check standards, blanks, spikes, and replicates, which

provide indications of the quality of data being produced by specified components of the measurement process. For each specified QC check, the procedure, acceptance criteria, and corrective action (and changes) should be specified. Data validation should document the corrective actions that were taken, which samples were affected, and the potential effect of the actions on the validity of the data.

21.1.5. Calibration

Section 16 addresses the calibration of instruments and equipment and the information that should be presented to ensure that the calibrations performed correctly, and the results are acceptable. When calibration problems are identified, any data produced between the suspect calibration event and any subsequent recalibration should be flagged to alert data users.

21.1.6. Data Reduction and Processing

As mentioned in the above sections, both internal and external technical systems audits will be performed to ensure the data reduction and processing activities mentioned in the QAPP are being followed. Periodically, raw data will be reviewed and final concentrations will be calculated by hand. The final values submitted to AQS should match the hand calculations. The data will also be reviewed to ensure that associated flags or any other data qualifiers have been appropriately associated with the data and that appropriate corrective actions were taken.

22. VALIDATION AND VERIFICATION METHODS

The purpose of this element is to identify the procedures, and responsible parties who will perform data validation and verification. Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual requirements. Data validation is an analyte and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e. data verification) to determine the analytical quality of a specific data set.

22.1. Validating and Verifying Data

The validation and verification procedures that will be employed for this operation shall conform to *Data Validation and Verification SOP.* Verification and validation issues are also discussed at length in *Guidance on Environmental Verification and Validation,* (EPA QA/G-8). All validation and verification activities shall be performed by the EHPS/QAC and the designated support staff. Additional support, including QC/QA activities, shall be provided by the AMM.

The data under evaluation should be compared to actual events as specified in *Data Validation and Verification SOP.* However, exceptional field events may occur, and field and laboratory activities may negatively affect the integrity of samples. In addition, it is expected that some of the QC checks will indicate that the data fail to meet the acceptance criteria. Data identified as suspect, or does not meet the acceptance criteria, shall be flagged as indicated in Table 21-1.

The review of the routine and the associated QC data will be verified and validated on a sample batch basis. The sample batch is the most efficient entity for verification/validation activities. The hypothesis is that if measurement uncertainty can be controlled at a batch level, then the overall measurement uncertainty will be maintained within the precision and bias DQIs.

22.2. Verification

After a sample batch is compiled, a thorough review of the data will be conducted for completeness and data entry accuracy. All raw data that are hand entered from data sheets will be checked prior to entry to the appropriate database. Once the data are entered, the data will be reviewed for routine data outliers and conformance to acceptance criteria. Unacceptable or questionable data will be flagged appropriately. All flagged data will be reverified to ensure that the values were entered correctly.

22.3. Validation

Validation of measurement data requires two stages, one at the measurement value level and another at the batch level. Records of all invalid samples shall be retained in the appropriate database. Information shall include a brief summary of why the sample was invalidated along with the associated flags. Logbook notes and field data sheets shall have more detailed information regarding the reason a sample was flagged. These documents shall remain with the field operators and/or at the monitoring site.

Certain criteria based upon federal requirements, and field operator and laboratory personnel judgment have been developed that will be used to invalidate a sample or measurement. The flags listed in Table 21-1 shall be used to indicate that individual samples, or samples from a particular instrument, have been invalidated. Filter-based samples shall be returned to the laboratory for further examination. Filters that have flags related to contamination, damage, or field complications shall be immediately examined. Upon concurrence of the laboratory technician and Laboratory Analyst, these samples shall be invalidated.

23. RECONCILIATION WITH DATA QUALITY OBJECTIVES

The purposes of Section 23 are to identify the acceptable methods for evaluating the project results, and provide an outline for the report required to document the findings. The DQOs for the Ambient Air Quality Monitoring Network were established in Section 7 of this QAPP. The resulting DQOs are for sampling or monitoring precision and relative bias. Section 19 discusses assessment and response actions. This section of the QAPP will outline the procedures that will follow to determine whether the monitors and laboratory analyses are producing data that comply with the DQOs, what actions will be taken as a result of the assessment process, who will perform, review, and approve this assessment, and who will generate the report that documents the findings.

23.1. Reconciling Results with Data Quality Objectives

This element includes scientific and statistical evaluations of data to determine if the data are of the right type, quantity, and quality to support their intended use. The EPA document *Guidance for Data Quality Assessment* (EPA QA/G-9) focuses on evaluating data for fitness in decision-making and also provides many graphical and statistical tools.

As described in *Guidance for Data Quality Assessment,* the DQA process is comprised of four steps. The steps are outlined below. Refer to *Guidance for Data Quality Assessment* for a detailed description of each step.

23.1.1. Five Steps of the Data Quality Assessment Process

As described in *Guidance for Data Quality Assessment* (EPA QA/G-9), the DQA process is comprised of five steps. The steps are outlined below. Refer to *Guidance for Data Quality Assessment* for a detailed description of each step.

Step 1. Review Data Quality Objectives and Sampling Design. The EHPS/QAC and the AMM shall review the project's sampling design, DQIs (precision, bias, comparability, representativeness, and completeness), and DQOs to verify that they are still applicable. Section 7 of this QAPP contains details for DQO development. Additional information contained in Section 7 includes methods for:

- Defining the primary objectives of the Ambient Air Quality Monitoring Network (e.g., NAAQS comparison).
- Translating the objectives into a statistical hypothesis (e.g., the three-year average of annual mean $PM_{2.5}$ concentrations is less than or equal to 15 $\mu g/m^3$).
- Developing limits on decision errors (e.g., incorrectly conclude an area is non-attainment when it truly is attainment no more than 5% of the time, and incorrectly conclude an area is attainment when it truly is in non-attainment no more than 5% of the time).

Section 10 of this QAPP contains the details of the Ambient Air Quality Monitoring Network design, including the rationale for the design, the design assumptions, and the sampling locations and frequency. If any deviations from the sampling design have occurred, these shall be documented for the DQA, and their potential effect carefully considered throughout the entire DQA.

verification will be addressed in this step. Note that when less than three years of data are available, this verification will be based on as much data as are available.

Data Quality Objective Assumptions. The DQOs are based on the annual arithmetic mean NAAQS. In the DQO development, it is assumed that the annual standards are more restrictive than the 24-hour, 8-hour, 3-hour, and 1-hour standards. Conceptually, DQOs can be developed for shorter averaging periods and more restrictive bias and precision limits selected. However, will assume the annual standard is more restrictive, until proven otherwise.

Measurement Error Assumptions. It is commonly assumed that measurement errors are distributed normally in environmental monitoring. *EPA QA/G-9: Data Quality Evaluation Statistical Tools (DataQUEST)* provides statistical tools for creating normal probability plots. If a plot indicates possible violations of normality, The EHPS/QAC and the AMM may need to determine the sensitivity of the DQOs to departures in normality.

Data error can occur when the estimated one- or three-year average differs from the actual or true one- or three-year average. This is not really an assumption as much as a statement that the data collected by an ambient air monitor is stochastic, meaning that there are errors in the measurement process.

The limits on precision and bias are based on the smallest number of required sample values in a one- or three-year period. In developing DQOs, the smallest number of required samples is used. This is to ensure that the confidence is sufficient in the minimal case. If more samples are collected, then the confidence in the resulting decision will be even higher. Data completeness evaluations will be performed each quarter to ensure that this DQO requirement is upheld.

Measurement imprecision is established at 10% coefficient of variation. For each monitor, the EHPS/QAC will review the coefficients of variation. If any exceed 10%, the EHPS/QAC and the AMM may need to determine the sensitivity of the DQOs to larger levels of imprecision.

Before determining whether the monitored data indicate compliance with a NAAQS, it must first be determined if any of the assumptions upon which the statistical test is based are violated. If any of the assumptions have been violated, then the level of confidence associated with the test is suspect and must investigate further.

Step 5. Draw Conclusions from the Data. Perform the calculations required for the statistical test and document the inferences drawn as a result of these calculations. If the design is to be used again, evaluate the performance of the sampling design.

23.2. Data Quality Assessment Report

A summary report, documenting the findings from the five steps associated with the DQA, shall be compiled, reviewed, approved, and distributed. The composition of this report shall parallel the DQA's five steps.

This report shall document any deviations experienced from the sampling plan for each criteria pollutant, on a site by site basis. The basic summary statistics, representative of the raw data sets, shall be calculated and presented along with the graphical presentation of the raw data. The report shall provide observations of the data patterns, structures, and relationships. Careful attention must be provided to identify, and document potential anomalous data.

Based upon the evaluation of the raw data, and insight mined from each DQI's condition, the data analyst shall select the most appropriate procedure for summarizing and analyzing the data. The report shall present these selected methods, along with the key underlying assumptions supporting valid statistical conclusions associated with these procedures, i.e. state the null and alternative hypotheses. A check will be performed of the selected analysis methodology, verifying that the underlying assumptions are valid or whether departures are acceptable. The actual data, and resulting raw statistics, along with the QA reported information will provide the foundation for this evaluation.

Apply the selected statistical tests on each data set's basic summary statistics. Evaluate, and draw inferences from the results. Document the projects findings, and provide conclusions and observations that may assist the project correct deficiencies for the next data collection period.

23.3. Action Plan Based on Conclusions from Data Quality Assessments

Each year, a thorough DQA process will be conducted. For this section, JCDH assumes that the assumptions for developing the DQOs have been met. If not, JCDH must first revisit the impact of the violation on the bias and precision limits determined by the DQO process.

If the conclusion from the DQA process is that each of the ambient air monitors is operating with less than 10% bias and precision, then JCDH may pursue action to reduce the QA/QC burden associated with the monitor. Possible courses of action may include the following:

• **Modifying the QA Monitoring Network** - 40 CFR Part 58 requires that each QA monitor be the same designation as the primary monitor. Once it is demonstrated that the data collected from the network are within tolerable levels of errors, JCDH may request that it be allowed to modify these requirements.

- **Reducing QC Requirements** - Quality Control is integral to any ambient air monitoring network and is particularly important to new networks. However, once it is demonstrated that the data collected from the network are within tolerable levels of error, may request a reduction in QC checks such as those specified in Table 14-1. However, if during any of the annual DQA processes it is determined that data errors approach or exceed either the bias limits or the precision limits, then JCDH will return to the prescribed levels of QC checks as indicated in Table 14-1.

If and when the data from at least one of the monitors or sites violates the DQI bias and/or precision limits, then JCDH will conduct an investigation to uncover the cause of the violation. If all of the monitors/samplers in the network of a similar type or pollutant violate the DQI, the cause may be at the agency level (operator training) or higher (laboratory QC, problems with method designation). If only one monitor/sampler or site violates the DQI, the cause is more likely specific to the site (particular operator, problem with the site). Tools for determining the cause include reviewing:

- data from a collocated network (JCDH, nearby reporting organizations, national),
- data from performance audits (contracted or NPAP), and
- QC trails.

Some particular courses of action include:

- **Determining the level of aggregation at which DQOs are violated -** The DQA process tells which monitors are having problems, since the DQOs were developed at the monitor level. To determine the level at which corrective action is to be taken, it must be determined whether the violations of the DQOs are unique to one site, multiple sites, or a network of similar monitors, or are caused by a broader problem. An example of a broader problem may be a particular sampler demonstrating poor QA on a national level. The AQS generates QA reports summarizing bias and precision statistics at the national and reporting organization levels by method designation. Examination of these reports may assist in determining the level at which the DQOs are being violated.
- **Communicating with EPA Region 4 -** If a violation of the bias and precision DQIs are found, will remain in close contact with EPA for both assistance and for communication.
- **Extensively reviewing quarterly data until DQOs are achieved -** JCDH will continue to extensively review the quarterly QA reports and the QC summaries until the bias and precision limits are attained.